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The Manufacture of Small Electrical Castings

Details of the Molding Practice in a Large, Modern, Continuous Foundry—How Meter and Flat Iron Parts Are Machine-Molded

By H Cole Estep

IN A foundry arranged to manufacture castings for a complete line of electrical apparatus, from large industrial motors to small household appliances, a great variety of equipment is necessary including facilities for pit and loam-molding, for large floor work with jar-ramming and roll-over machines and for the rapid production of thousands of small castings weighing from a few ounces up to three or four pounds. For the latter work an elaborate mechanism is necessary, including not only molding machines, but devices for rapidly and economically handling the sand, transferring the hot metal and removing the finished castings. To insure a remunerative output per man per day, every detail of the process must receive intensive study and the problem, therefore, presents an unusually large number of points of interest.

Success in the manufacture of small castings, whether they be for electrical apparatus or for other purposes, hinges largely on the methods adopted for handling materials and for executing the details of molding. The experience of the past few years has demonstrated

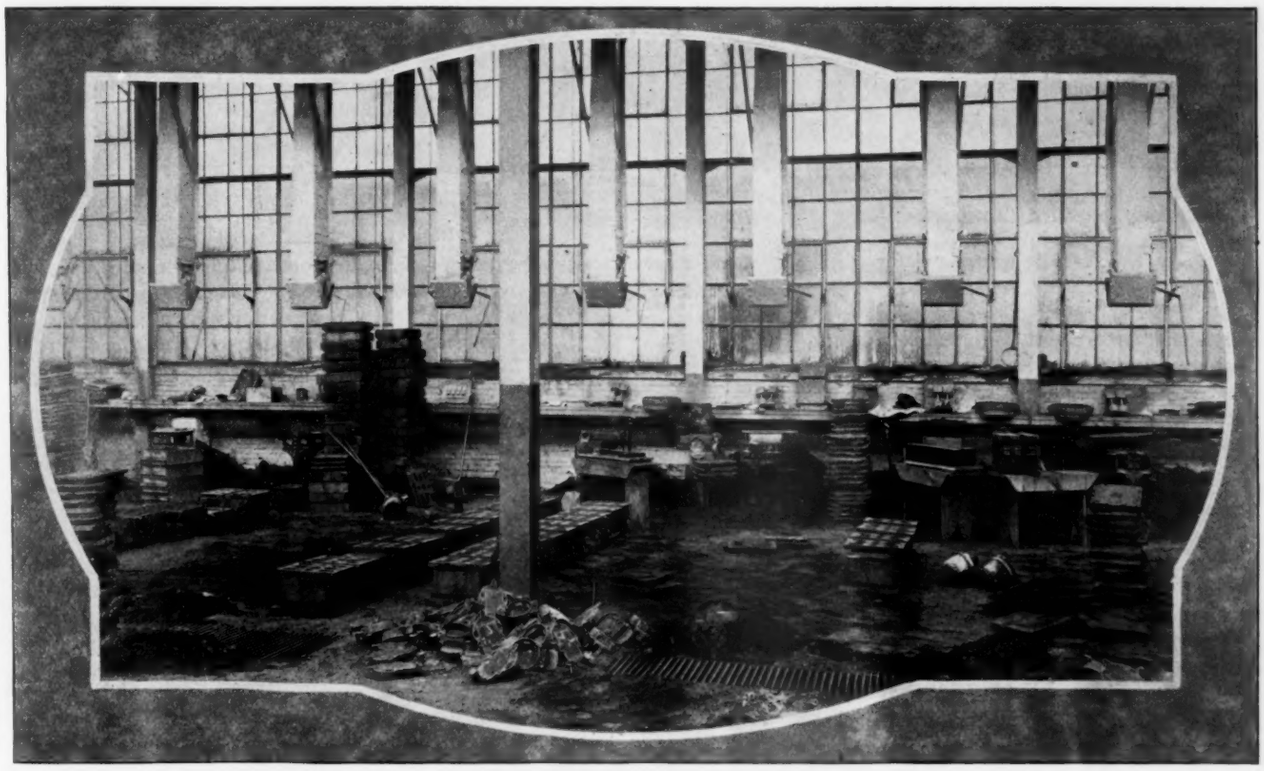


FIG. 1.—A TYPICAL SECTION OF THE WESTINGHOUSE CONTINUOUS FOUNDRY IN CLEVELAND, SHOWING ARRANGEMENT OF SAND CHUTES, MOLDING MACHINES, SHAKE-OUT GRATINGS, ETC.

that continuous molding and pouring, supplemented by effective mechanical appliances for handling and tempering the sand, brings unusual results with this class of work. A large number of continuous foundries of various types, therefore, have been built in this country recently. One of the latest shops of this character, designed for the continuous production of small electrical castings, is that recently completed in Cleveland by the Westinghouse Electric & Mfg. Co. In this connection it is interesting to observe that the Westinghouse interests were among the first to adopt continuous methods in the United States, in the foundry of the Westinghouse Air Brake Co., Wilmerding, Pa., a suburb of Pittsburgh. This plant, in which the molds are carried to a central pouring station, has been in successful operation for several years. In many respects, however, the Cleveland plant differs from its Pennsylvania predecessor, in that the molds are poured on the floor where they are made and novel arrangements are provided for handling the hot metal, sand and finished castings.

Arrangement of the Shop

A complete description of the new continuous foundry of the Westinghouse Electric & Mfg. Co. at Cleveland will be presented in an early issue of *The Foundry*, to which this article, covering the methods of molding certain typical castings, may be considered an introduction. Before going into the details of molding, however, it is necessary to present certain facts regarding the arrangement of the shop.

All the work is handled on molding machines which are arranged in two rows along either side of the shop. A small floor is provided for each machine on which the finished molds are placed; the work, however, is poured and shaken-out practically as fast as it is made. The molds are shaken-out over a grating in the floor, through which the sand passes to a conveyor belt beneath. This belt delivers the worn sand to a central screening and tempering station, where it is mixed with the requisite amount of new sand and made ready for use again.

Handling the Sand

The prepared sand, which is handled by a system of elevators and belt conveyors, is delivered to chutes placed over each molding machine. A typical floor showing the arrangement of the molding machines, sand chutes, shake-out grating, etc., is shown in Fig. 1. The men at the machines have practically nothing to do but mold; the sand is delivered direct to their flasks, ready for use, and the work is poured and shaken-out by a separate gang. The iron is melted in three Whiting cupolas, 54 inches inside diameter, rated at 12 tons per hour each. The hot metal is delivered to the floors by an electrically-driven, cab-controlled telpher furnished by the Brown Hoisting Mchy. Co., Cleveland. The castings are removed to the cleaning room in suitable buggies.

This foundry turns out a great variety of work including such castings as resistance grids, small motor frames and house meter cases and frames. From a molding standpoint, the latter present certain features of interest, which it is now proposed to describe in some detail.

In the manufacture of Westinghouse single-phase alternating current watthour meters, such as are used in stores and residences for measuring electrical energy, two light gray iron castings are required, a case or back and a frame carrying the moving parts. The cover, which fits into a recess in the case, protecting the mechanism from injury, is made either of pressed zinc or glass.

The case, shown in the rough in Fig. 6, weighs about 3½ pounds finished and has an average metal section of ⅛-inch. It is necessary that it be strong, rigid and dust-proof, as well as accurately molded in order to have a suitable finish and to avoid machining. The meter case proper and the accompanying terminal chamber, into which the wires connected with the outside circuits are led, are cast integrally, separated by a 1/16-inch wall. This design, while producing an advantageous product from a commercial standpoint, adds to the difficulties of the foundryman.

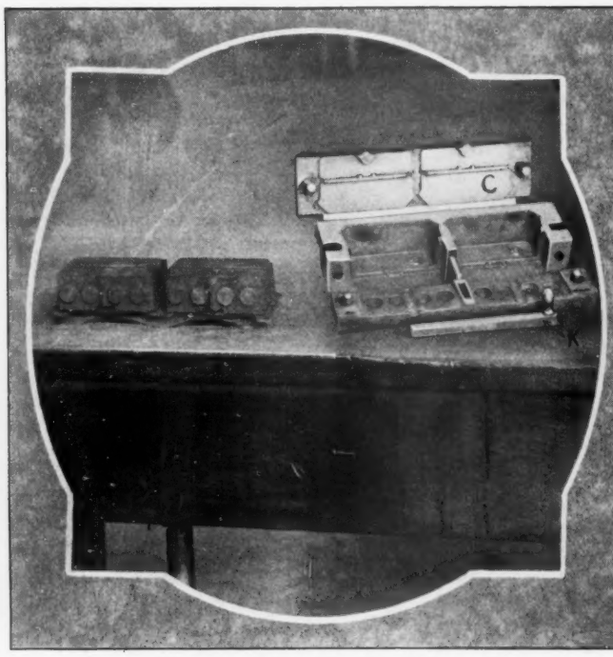


FIG. 2.—DETAIL OF CORE BOX—TWO FINISHED CORES ARE SHOWN ON THE DRIER PLATE AT THE LEFT

FIG. 3.—STRIPPING TERMINAL-CHAMBER CORES OUT OF THE BOX

Green Sand Core

The core forming the interior of the case is made in green sand, the terminal chamber being formed by a dry sand core that must be very accurately made and set. The casting is molded on stripping plate machines furnished by the Osborn Mfg. Co., Cleveland. These machines are provided with a 3¼-inch draw.

The dry sand, terminal-chamber core, which is shown in Fig. 2, must be accurate to 0.01-inch and must fit without filing. Also, since a complete 5-ampere meter is listed at only $19.50, the cores,

molds and castings must be turned out with the utmost economy and in large quantities. The terminal-chamber cores, therefore, are made by semi-skilled girls in a specially equipped, separate core room. To insure accuracy, cerefully machined metal core boxes are provided, together with special rigging that permits five girls to turn out 4,000 good cores a day. The girls' core room is situated on a mezzanine floor directly over the ovens and sand mixing apparatus. The sand, ready for use, is delivered to bins in the core room by an elevator, another elevator being used to carry trays of finished cores to the ovens. Each girl transfers her own sand from the storage bin to her bench.

The benches are arranged on both sides of the room with the finished-core elevator in the center. The sand bins are at one end. As fast as each girl finishes a tray of cores, she places it on a table near the elevator, from which it is transferred to the elevator, which is of the pan type, by another employe detailed for that purose. The coremaker therefore, does not have to waste time waiting for an opportunity to load her particular tray onto the elevator.

A detailed view of the core, drier-plate and core box is shown in Fig. 2. It will be noted that two cores are made at one time. Each core is 4 inches long, 2½ inches wide and 1½ inches thick. The form is rectangular, with a circumferential groove forming a stiffening rib on the inside of the casting. The core box, which is 11 inches long, 3½ inches wide and 2½ inches deep, is made in three parts fitted together by machined pins. The front of the box, which is held in place during the ramming operation by the key *K*, Fig. 2, forms four circular bosses on the core. These bosses serve to reduce the thickness of the metal, forming knock-out plates through which the wires enter the terminal chamber of the meter. If it were not for these bosses, it is plainly evident that the core box could be made in two parts.

Details of Core Bench

After the core is rammed up and the cover-plate *C* removed, the box is rolled over and placed on the draw-bench shown in Fig. 3. This bench is provided with a stripping plate through which the core is lowered out of the box, the operation being performed by pressing the foot treadle with which the bench is provided. This produces a core with square sides, practically no allowance for draft being necessary. Fig. 3 also shows the general characteristics of the coremaker's benches, which are simply constructed with cast iron legs and wooden tops. Each bench is provided with a drawer for small tools, etc. With this equipment, a girl after reasonable training, can easily turn out 900 meter-case, terminal-chamber cores in a day.

A normal mixture of fine sand, glutrin and dry core compound is used for making the cores. The sand, which is as fine as can be obtained, is riddled through a No. 4 screen.

Fig. 4 shows the core elevator mentioned previously, with a tray of finished cores ready to be sent to the oven on the floor below. The sand bins and discharge-end of the sand elevator are shown in the background in this illustration. The core elevator is driven by a motor through enclosed gearing. It is also provided with a 12-inch diameter ventilating flue through which odors given off by the cores are removed.

The cores are baked in a seven-section, drawer-type, coke-fired oven furnished by the Coleman Foundry Equipment Co., Cleveland. As shown in Fig. 5, each section is equipped with seven drawers, the outer ends of which are supported by a four-wheel trolley running on channel beams. The discharge end of the core room elevator is placed so that it is convenient to all of the oven sections, the average transfer distance being 12 feet. The trays of green cores are shifted from the elevator pans to the oven sections by a man detailed for that purpose.

The meter cases are molded in snap flasks, using Osborn stripping plate machines. The men work in pairs with two machines for each floor, one man making copes and the other drags. The man who makes the copes also transfers the finished molds from the bench to the floor and distributes the pouring weights. The details of the mold, together with the drag machine and rough casting, are shown in Fig. 6. The flask is 11 x 13 inches inside measurement, the cope being 3 inches and the drag 4 inches in

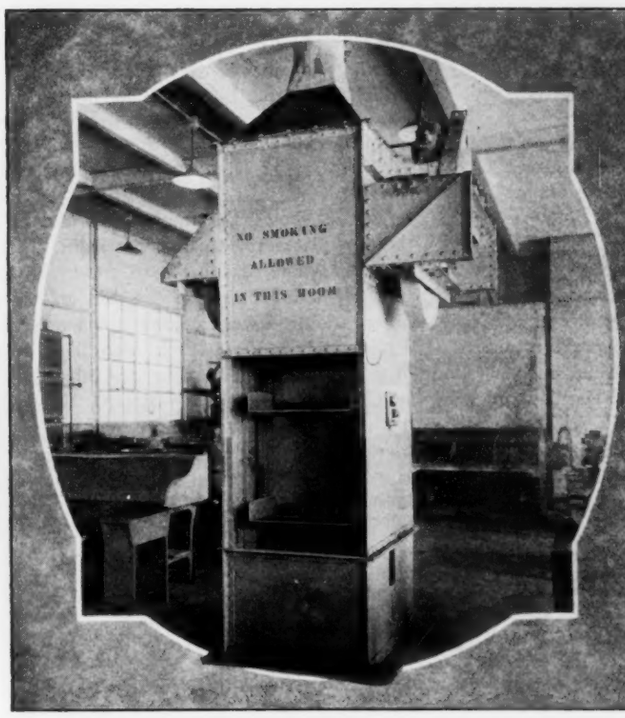


FIG. 4—ELEVATOR FOR TRANSFERRING GREEN CORES TO OVENS ON FLOOR BELOW—THE SAND BINS ARE SHOWN IN THE BACKGROUND

FIG. 5—A SECTION OF THE COKE-FIRED, DRAWER TYPE OVENS USED FOR BAKING SMALL CORES—EACH OVEN HAS SEVEN SHELVES

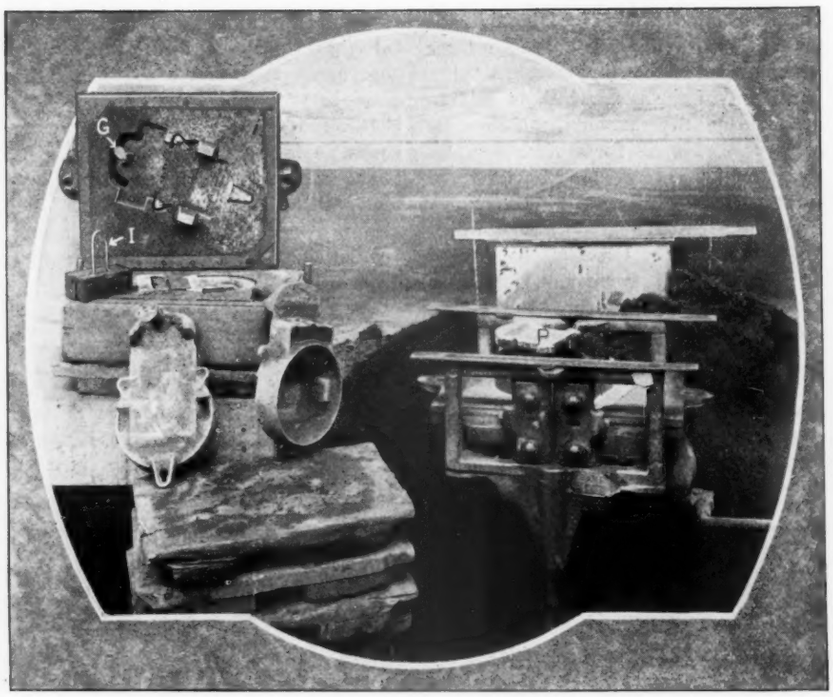


FIG. 6—COPE AND DRAG FOR METER-CASE CASTING—THE ROUGH CASTING IS SHOWN IN THE FOREGROUND AND THE DRAG STRIPPING-PLATE MACHINE AT THE RIGHT

depth. The man who molds the drags is semi-skilled and is held responsible for the success of the work.

The pattern, as shown in Fig. 6, is of metal. When the pattern is stripped-out of the drag mold, the heavy green sand core forming the interior of the meter case, is prevented from dropping by the plate *P*, which remains stationary.

The metal is poured through a single runner which connects with the terminal-chamber end of the casting through a bifurcated gate shown clearly at *G*, Fig. 6. There is no riser. Formerly two castings were made in the flask, but it was found difficult to avoid chilling. Special difficulty was experienced in running the thin circular rim of the casting. Since the present method of making one casting in the flask was adopted, this difficulty has been overcome entirely.

The dry sand, terminal-chamber core must be set accurately and for this purpose the wire clip *I*, Fig. 6, is provided. The use of this clip makes it easy to set the core in exactly the right position. After the casting is made, the thickness of the walls of the terminal-chamber is tested with a gage and a core displacement of 1/32-inch is sufficient cause for rejection.

Fig. 1 shows how the floor is arranged, the molds being provided with jackets and weights for pouring. As mentioned previously, the castings are shaken-out over the gratings shown in the foreground in this illustration. A number of fresh castings, awaiting the arrival of the cleaning-room buggy, are also shown around the post in the foreground of Fig. 1. These castings are made from an ordinary light gray iron mixture running about 2.50 per cent silicon. The metal is poured extremely hot in order to avoid cold-shorts and to produce a properly finished casting.

The method of molding the cast iron frame which supports the moving parts of the meter is shown in Fig. 7. These frames fit into the cases previously described. Four castings are made in a 12 x 14-inch snap flask. The copes and drags are each 3½ inches deep. As in the case of the meter cases, each floor is provided with two stripping plate machines, one for making copes and the other for forming the drags. The main cores, which are green sand, are suspended from the cope. The method of gating the castings is shown very clearly in Fig. 7. A single runner terminating in a four-way channel is used. Each casting, therefore, is gated at two points, insuring the quick and complete filling of the mold. There is no riser. Two men turn out about 250 of these molds per day, giving a total production of 1,000 castings.

The shelf on which rammers, riddles, bottom-boards, etc., are stowed is shown in the background of Fig. 7. This shelf consists simply of two stringers supporting a coarse wire screen through which the sand filters. The shelf runs the entire length of the shop, serving every molding floor.

Molding Flat-Iron Plates

Fig. 8 shows the method of molding bottom plates for electric flat irons. The stripping-plate machine used for molding the copes is shown at the left of this illustration. Two castings are made in each mold, a 10 x 14-inch snap flask being employed. The cope and the drag are both 3½ inches in depth. It will be noted that the castings are run entirely in the cope, the drag containing nothing but the gate which is provided with a skimming bridge furnishing clean metal. The runner is located in the center of the mold and after the metal

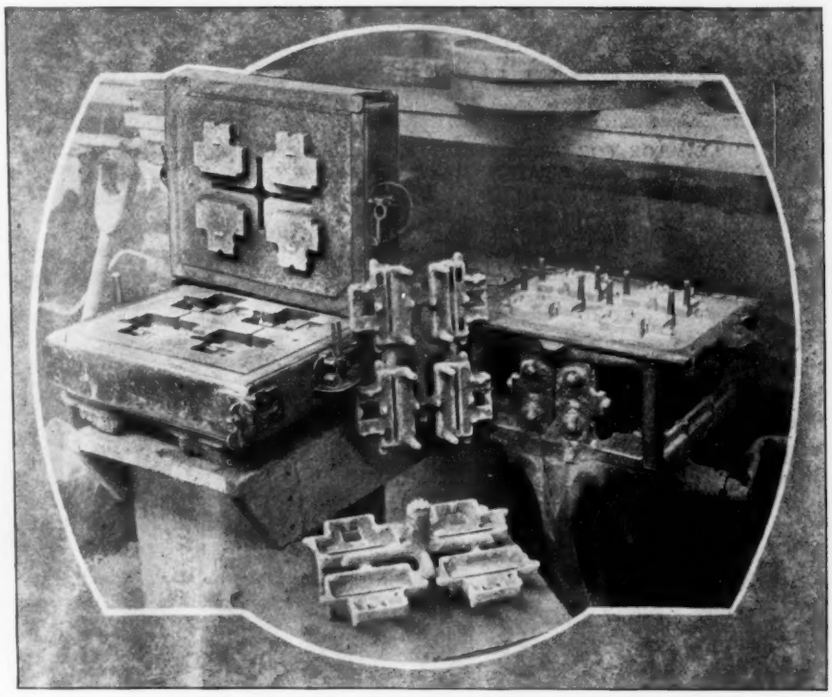


FIG. 7—FLASK CONTAINING FOUR METER FRAMES—THE DRAG-MOLDING MACHINE IS SHOWN AT THE RIGHT

passes under the skimming bridge, which is formed by a dry sand core, *M*, Fig. 8, it passes through the channel *H* in the cope, the lower or rear end of which connects with the double-ended gate *T*. The gate extends alost entirely across the back of the casting, filling the mold very quickly.

The rough castings are transferred to the cleaning and grinding department for finishing. A portion of this department is shown in Fig. 9. It is equipped with 20 tumbling mills, in which the castings are rattled before being trimmed on the grinding wheels. The men in the foreground of Fig. 9 are grinding flat iron castings. Each wheel is provided with a hood, connected to a powerful dust exhaust system, which keeps the atmosphere in the grinding room almost perfectly clean. The photograph from which Fig. 9 was made was taken instaneously while the plant was in full operation and the absence of dust is self-evident.

As fast as the castings are ground they are dropped onto a slowly moving conveyor placed between each double row of machines. This conveyor discharges the finished castings onto a receiving table shown at the left in Fig. 9, from which they may be transferred directly to outgoing cars.

The Electric Steel Co., Chicago, recently organized to engage in the manufacture of steel for casting purposes by the electric process, contemplates placing its plant in operation about the middle of March.

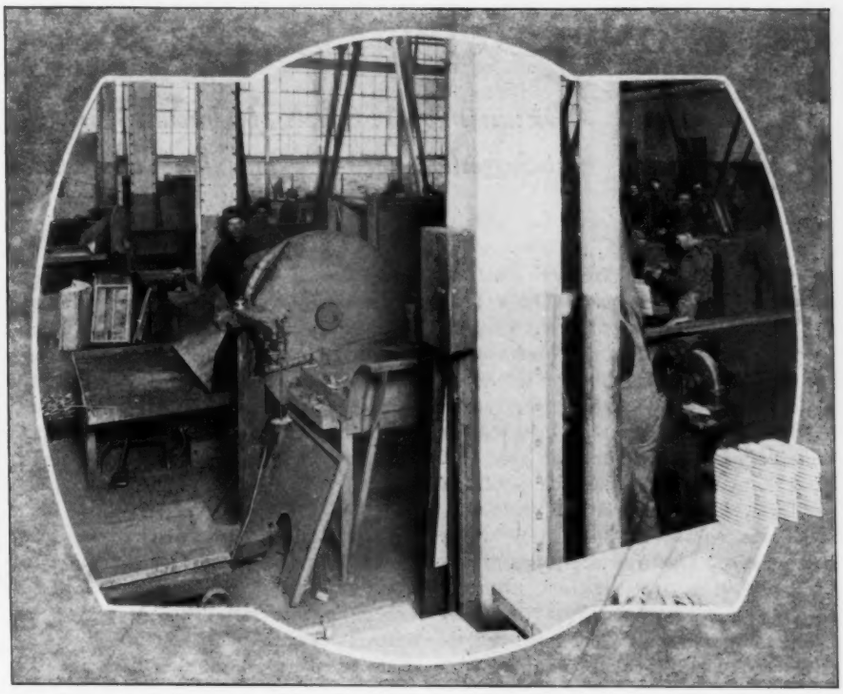


FIG. 9—A PORTION OF THE GRINDING ROOM, SHOWING CONVEYOR FOR DISCHARGING FINISHED CASTINGS ON THE SHIPPING PLATFORM

English Agency Established

The Snyder Electric Furnace Co., Chicago, has established an European agency with headquarters in the Old Bank Chambers, Bradford, Yorkshire, Eng., which is in charge of G. J. Stock, the inventor of the converter known by that name. This foreign office has closed contracts for the following electric furnace installations in England: The Daimler Co., Ltd., one furnace, three tons in 24 hours; Thwaites Bros., two furnaces, each with a capacity of 12 tons in 24 hours; Summerson & Sons, Ltd., one furnace with a capacity of 12 tons in 24 hours and the National Steel Foundry Co., Ltd., Scotland, one furnace, with a capacity of six tons in 24 hours. In addition, four large furnaces for smelting work have been contracted for, as well as a small furnace for carrying on initial experimental work in connection with this smelting.

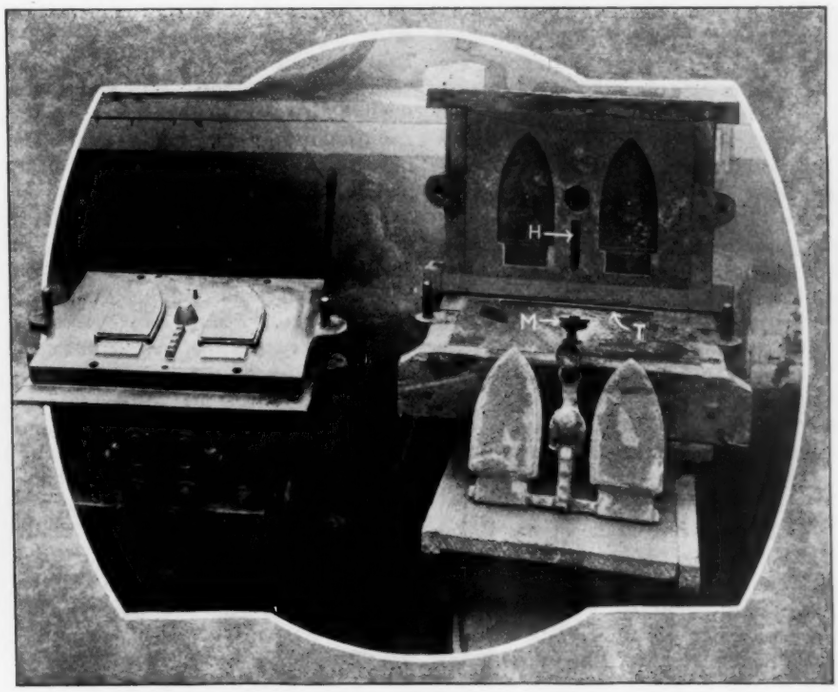


FIG. 8—MOLD FOR ELECTRIC FLAT-IRON BOTTOMS, SHOWING PECULIAR GATE PROVIDED WITH DRY-SAND SKIMMING BRIDGE

Foundry Supplies and Equipment for Italy

Charles F. Hauss, president of the American Chamber of Commerce, of Milan, Italy, who has been in this country for several months, returned to Milan Feb. 26, after having made arrangements with American manufacturers of pig iron and foundry supplies to act as their representative in Italy. Mr. Hauss expressed the opinion that there is a large market for American raw materials and machinery of all kinds in Italy. Heretofore the supplies for Italian foundries were shipped largely from Germany, Austria and England. Mr. Hauss is a native of Cincinnati and formerly represented the American Radiator Co. abroad. His address at Milan is 16 Via Alberto da Guissano.

It is estimated that the output of lead in 1915 was over 600,000 tons, compared with 522,864 tons in 1914, an increase of about 15 per cent.

Remedying Defects Common to Gray Iron Castings

A Discussion of the Causes of Unsound Cast Sections, with Pertinent Suggestions for Overcoming Them and Reducing the Scrap Pile

By Herbert M Ramp

A COMPREHENSIVE discussion of the causes of defects common to gray iron castings and remedies for overcoming them would encompass the consideration of practically every foundry operation. A discussion of the losses incurred by defective castings is one of the first things a man hears when he enters a foundry and it usually is the last thing that comes to his notice when he leaves it. Unfortunately, more attention is given to the losses incurred by defective castings than to making improvements that will eliminate practices that cause them. More consideration is given the pounds of bad castings a molder produces than to his output of good work. Also, more importance is attached to the bad castings reported than to the cost of productive labor per ton. The reason for this is not hard to find. The one is a tangible, direct loss that stares the foundryman in the face every day, while the others are intangible factors that can be corrected by the exercise of gray matter and the installation of proper equipment.

Incompetency and Carelessness

It is estimated that defects common to gray iron castings are the direct cause of the rejection, or loss, of at least 5 per cent of the iron castings produced. Some patterns may have a better record, although many, also, will show a higher percentage of loss. This estimate on the average, however, is low. If this loss were eliminated many foundries struggling for existence today could net a profit on their operations. The reduction of the defective output is a problem of great importance and should command the earnest attention of every foundryman.

Ninety per cent of all defects can be attributed to two causes, namely, incompetency and carelessness. However, since it is exceedingly difficult to obtain competent and careful labor, the operations involved in making castings today must be so safeguarded and simplified that a lesser degree of experience, intelligence and care is necessary to the successful operation of the casting plant than heretofore. Classifying casting losses in the order of their causes, it will be found that 50 per cent can be attributed to the sand and its treatment, 20 per cent to the cores, 10 per cent to the patterns, 5 per cent to equipment and 5 per cent to the iron.

What Constitutes Defectives?

What constitutes defects in gray iron castings is another question of great importance. The standard of excellence for the different classes of castings varies and consumers using castings of a similar nature for the same purpose, frequently will have widely varying requirements. In other words, castings that will be accepted by one company will be rejected by another and the line differentiating sound from defective castings is drawn at different points. In this respect every consumer is a law unto himself, and there really is no standard for casting quality. Each consumer fixes what he considers a standard for his own requirements which he believes is adequate to his needs.

No effort will be made to enumerate the many causes leading to the production of defective castings as the list will be entirely too long and, furthermore, in many instances the causes are so obvious that further comment is unnecessary. However, some practices are common to many shops which cause needless expense and these are repeated day after day in one form or another without an intelligent effort being made to correct them. The sand, and its treatment, is probably one of the most prolific causes of defects, and to it can be attributed more losses than to all other causes combined. In three cases out of four, the sand is the cause of dirty castings; it causes the mold to cut and the castings to scab and blow. If a casting blows, it generally is attributed to the cores, the sand or its treatment, and its repetition is guarded against. However, the cause of the cut, scab or buckle is not investigated carefully, notwithstanding the fact that the losses thereby incurred are deadly to profits. It is the small defect that causes the foundryman to stop and wonder if the casting will pass the machine shop, but finally after it has been cleaned and shipped, it is returned with a caustic letter of complaint. It might be pointed out in this connection that the little foxes spoil the grapes. A casting that is defective beyond question usually points out its own remedy, but the casting which is questionably defective is the most elusive. The remedy is not sought as earnestly or intelligently as that causing the larger defect, neither are the molders instructed as carefully to prevent the causes of small defects as those which are more apparent.

The foundryman usually becomes provoked and exceedingly angry when a molder has a run-out or breaks a casting hot. He views this in the light of exceedingly poor workmanship, but he considers in an entirely different spirit a casting that is slightly scabbed or dirty. The casting that is *almost good enough* offers the most difficult problem and the cause of its defect, as a rule, cannot be determined readily.

Scabs, Cuts and Buckles

Scabs, cuts and buckles come and go. They vary with the temperament of the man who wields the rammer and the vent wire and blossom forth with the use of too much water, too much finishing, too little venting and the use of improper sand. When the foundryman discovers a scabbed casting, he usually tells the molder to be more careful, or advises him that the mold was too hard or too wet, or whatever his judgment dictates, but how often does he examine the facing and the sand? How often does he employ every possible resource to secure better sand or to make mixtures of sand for his work that are more satisfactory? How often does the foundryman show the molder how to ram the mold, to vent or finish it? How many foremen today believe that they discharge their duty by merely telling the men in their employ what is patent to any one who has walked through a foundry a few times in place of personally instructing them how to avoid their troubles and to do their work right?

Poor or misused sand is the cause of more defective castings than any

Presented at the Atlantic City meeting of the American Foundrymen's Association.

other factor. It has a decided influence on the cost of the product and may be the means of establishing a reputation for high grade or poor castings. It is the foundation upon which the entire foundry structure is built. Suitable sand means better and cheaper castings, lower losses and an easier shop to operate successfully. It is one of the great fundamentals of a happy business.

Preparation and Use of the Sand

Next in importance are the instructions issued regarding the preparation and use of the sand after its careful selection, consistent with its cost. However, cheap sand frequently is the most expensive raw material that a foundry can buy. The sand must be mixed and tempered for the particular work for which it is required and this must have the attention of the supervising force. The molder next must be instructed in its use and if defects develop in his work, he must be taught, regardless of the fact that he may have pounded sand for 40 years. It is futile to attempt to formulate fixed rules covering supervision and instruction, since every foundryman has individual ideas on this subject. However, not many realize that the cause of defective castings might be eliminated if they would start at the sand bin and see to it that the best possible sand is obtained and that the proper instructions are given regarding its use. Too frequently, also, this instruction partakes of the form of criticism, when the molder is called to the scrap pile where his defective castings are pointed out to him in no uncertain terms. In other words, in most instances, what should be well-intended instruction, is mere denunciation. Anyone can find fault, but a man must study his business if he wants to place himself in a position where he may be able to correct bad practice.

The average molder does not lose a casting on purpose. He feels regretful over its failure, but the average molder does not always know the underlying cause of defects, nor how they may be overcome. He must be taught the rudiments of the business over and over again, since the conditions of the trade are changing constantly. This is the remedy that must be applied by the supervising force before the defective losses can be reduced. If the same energy is expended in instruction as in condemnation, far more satisfactory results will be achieved.

Dirt ranks as the second of the prolific causes of defective castings. From a molding standpoint, the casting may be perfect, yet it is dirty in the rough, or it may display dirt spots in the finishing operations. The number of excuses attributed as the causes for dirty castings is legion, yet only two can be assigned for this defect. Either the iron does not lie quiet in the mold, or against the cores, or dirt has been permitted to enter the mold with the iron, or it was in the mold at the time when the metal was poured. Occasionally the blacking may wash; again the gates will cut, but more often the dirt can be attributed to the same cause as that of the scab or buckle, namely, improper sand, or its improper treatment. A casting will not be clean when the iron does not lie quietly in the mold. The metal may not boil or agitate sufficiently to cause a scab, yet its effect is apparent on the finished casting. If the slag which accumulates on top of the iron is permitted to enter the mold, the casting, of course, will be dirty and this is true also if the gates cut or scab, or if the gates or runners are improperly constructed, or are defective in any way. It is possible to make a perfect mold, yet if the gates are improperly made, the casting will be dirty and will prove defective. Here again the remedy is care and supervision.

Dirty Iron

An excuse generally offered for defectives is dirty iron. This is the bulwark behind which the molder hides and is the shield which he employs to cover his shortcomings. First of all, it might be well to direct attention to the fact that iron and dirt are enemies and have nothing in common. The dirt referred to is the foreign substance that occurs or forms on the upper side of finished castings. Iron and dirt have no affinity and are of widely different specific gravities. Ninety per cent of the so-called dirt in castings is composed of silica, alumina and magnesia and none of these is mixed with iron mechanically. They will not remain in solution by any known process, but they may unite to some extent chemically, in this event changing the chemical composition of the iron. This, of course, could be readily determined. However, the natures of these elements are not similar, repelling each other, which is indicated when such substance rises to the surface of the metal in the ladle. Some of the different oxides contain iron, being formed while the iron is in a liquid state and subjected to the action of the oxygen in the air. These oxides also are classed as dirt. However, this dirt, the same as any other refuse that rises to the surface of the metal in the ladle, must be skimmed-off before pouring and does not form a part of the iron. Oxides cannot form, however, after the casting is poured.

Hot, Clean Iron

Iron is unlike most of the nonferrous metals, in that it will form only a comparatively few combinations with the exception of those produced in the blast furnace. It repels all but a few elements that are taken up in almost constant proportions and these only at extreme temperatures. Regardless of the composition or the character of the iron, if it is melted and poured fairly hot, it will be clean. The sulphur may be 0.05 or 0.20 per cent, the manganese may be 0.20 or 2 per cent, the phosphorus may be 0.10 or 1.25 per cent, but none of these varying contents of these elements will make iron dirty in the castings. The iron may be too hard, too soft, too open; it may shrink, crack, draw or warp, but dirt is not its inheritance, nor its progeny.

During the past 25 years, the author has had direct charge of the mixing and melting of more than 500,000 tons of iron, but he has yet to find dirty iron in the sense assigned for it by the molder. Why does a molder make nine castings good and one bad? Why does a molder make a clean record for 30 days and then lose everything he makes? If a molder can produce 20 good castings why is he unable to make 21 or 200? These are the questions put up to the foundryman every day and he has yet to give a convincing answer. First of all, there are no standards or set regulations governing foundry work. The sand may be wet down more one day than another and this makes different the ramming, venting and finishing problem if the castings are to be good. The iron may be colder and duller one day than another, and this would necessitate the use of gates of different size, or different pouring arrangements and the cores may be swelled out of shape, which would require different methods of securing. The flasks may be worn out and finally give way and a hundred other conditions may arise which never are the same on subsequent days.

Little has been done in most shops to remove the many causes of defective castings, except in foundries specializing in a particular class of work. No effort has been made to catalog the ills of the foundry and no one has attempted to place the foundry business on a level with the machine shop. If this were done, many and

marvelous changes would be made. The patterns, core boxes and flasks would be inspected daily, the sand would be prepared by machinery and the different grades and ingredients would be carefully measured; different rules would be laid down covering the pouring temperature of the metal, as well as the methods of gating. The foundryman would have a voice in the design of the patterns and he also would have the patterns made, not the cheapest way, but the most satisfactory way for foundry use. Every possible pattern would be mounted on a molding machine instead of placing so much dependence upon the skill of the individual operator. Either by lectures, by a school course, or through technical papers, would be imparted to the molders the knowledge gleaned by the employers as the result of the development of the business. Premiums would be paid for high grade service and efficiency.

The Personal Equation

The foregoing and many more factors would contribute as remedies for defective casting losses. Unfortunately, these needs cost money and the trail has to be blazed; some must be pioneers in elevating foundry practice to a class where definite standards exist and where definite practices will produce definite results.

In a large measure the personal equation will have to be limited and particular jobs will have to be so safeguarded that if Tom Jones lays off a day, his substitute won't make 50 per cent scrap; that if Mike Murphy has been out the night before, he won't spoil his day's work; or, if a molder has sickness at home, he won't forget some minor detail and ruin his casting. More of the responsibility, judgment and skill must be taken away from the individual and the work must be placed upon a higher mechanical basis than it is today. Then only, will the beginning be made for the elimination of defects in castings. An honest comparison of the defective work of the ordinary jobbing foundry with that of the shop equipped for a special line of work, proves conclusively that defectives can be reduced by placing operation on a higher mechanical plane.

Ohio Rules Governing Foundry Operations

AS A result of public hearings held at Cleveland, Cincinnati and Springfield, O., during 1915, rules relating to foundries and the employment of women in core rooms have been prepared by the committee on foundries and the general safety advisory committee has recommended them to the Industrial Commission of Ohio for enforcement on and after Jan. 1, 1916, unless later action is taken by the advisory committee. In the meantime these rules have been sent to the foundries throughout Ohio, with the statement that they have been adopted by the advisory committee and have been recommendsd to the Industrial Commission of Ohio.

The committee on foundries consisted of representative casting manufacturers of the state and was constituted as follows: H. J. Boggis, chairman, Taylor & Boggis Foundry Co., Cleveland; Thomas D. West, deceased, West Steel Casting Co., Cleveland; J. M. Woltz, Youngstown Sheet & Tube Co., Youngstown, O.; D. J. Ryan, Allyne-Ryan Foundry Co., Cleveland, and George A. Pickup, Wehrle Stove Co., Newark, O. The labor representatives on this committee consisted of John R. O'Leary, Box 669, Cincinnati; John O'Neil, 446 W. First avenue, Columbus; Fred L. Baumgardner, 505 Superior building, Cleveland, and Timothy Rowan, 939 Central avenue, Hamilton, O.

In many respects the rules are similar to those adopted in New York and Pennsylvania, but are presented in full herewith to note additions and eliminations from the rules of these states which have been found desirable since these rules have been in effect:

Rule 1—An iron or steel foundry shall mean a place where iron or steel or both metals are melted and poured into sand molds in the making of castings, together with all cleaning, coremaking, drying, wash rooms and toilet rooms used in connection therewith.

Rule 2—The term "entrance", as used in these rules, shall mean main doorways opening directly to the outer air.

The term "gangway" as used in these rules shall mean well-defined passageways dividing the working floors of foundries, but not the spaces between molds. Spaces between molds shall be divided into three classes, which shall be known as "bull-ladle aisles", "hand-ladle aisles" and "buggy-ladle aisles".

Rule 3.—Except as otherwise specified, these rules shall, as to the subjects covered herein, exempt foundries from the general rules relating to such subjects.

Entrances

Rule 4—Entrances to foundries shall be protected from November first to April first of each year by a covered vestibule, either stationary or movable, which shall be so constructed as to eliminate drafts and of such dimensions as to answer ordinary purposes, such as the passage of wheelbarrows, trucks and small industrial cars. This shall not apply to entrances used for railroad or industrial cars handled by locomotives or motors, or for traveling cranes, horse-drawn vehicles or automobiles; these entrances may remain open only for such time as is necessary for the ingress and egress of such cars, trucks and cranes, horse-drawn vehicles or automobiles.

No locomotive shall be permitted to remain inside the foundry during the loading or unloading of the cars.

Gangways

Rule 5.—Main gangways where metal is carried by hand, bull or truck ladles shall be not less than 5 feet wide. Truck-ladle gangways which are not main gangways shall be not less than 4 feet wide. Bull-ladle aisles between floors shall be not less than 3 feet wide. Single hand-ladle or buggy-ladle aisles between floors shall be not less than 18 inches wide. Where trolleys are used over molding floors for pouring metal, the aisles shall be of sufficient width to permit the safe ingress of employes and the safe use of the ladles. Where it is necessary to occupy the central portion of the floor space in the production of molds, continuous gangway space shall be provided.

Rule 6.—During the progress of casting every gangway or aisle shall be kept entirely free from pools of water or obstructions of any nature. Every gangway where industrial tracks are used shall be constructed of a hard material of substantial character and the top of the rails shall be flush with the floor. Every gangway shall be kept in good condition at all times.

Removal of Smoke, Steam, Gases and Dust

Rule 7.—Where smoke, steam, gases or dust arising from any of the operations of the foundry are dangerous to health or eyes, and where a natural circulation of air does not carry off such smoke, steam, gases or dust, there shall be installed and operated hoods, ventilators, fans or other mechanical means of ventilation approved by the Industrial Commission of Ohio.

Rule 8.—The cleaning and chipping of castings shall be done in cleaning rooms except that where traveling cranes or where, in existing installations, cars are used for conveying castings into such rooms, a separating partition shall be erected which shall be not less than 12 feet in height. In existing installations, where the crane cage or crane girders will not permit the erection of a 12-foot partition, the height of the partition may be reduced sufficiently to permit the clearance of same. Large castings may be chipped or cleaned by hand in the molding room or where cast, provided sufficient protection is furnished by the use of a curtain or screen or some other means equally good to protect employes who are otherwise employed therein.

This rule shall not apply if mechanical contrivances are used for cleaning castings and the dust and particles arising therefrom are effectively removed satisfactorily to the Industrial Commission of Ohio.

Rule 9.—Where tumbler mills are used, exhaust systems shall be installed to effectively carry off the dust arising from the cleaning of castings, except where the mill is operated outside the foundry. This does not prohibit the use of a water barrel for the purpose of cleaning castings. Sand blast operations shall be carried on in the open air or in a separate room used solely for that purpose. The milling of cupola cinders, when done inside the foundry, shall be carried on by an exhaust mill or water mill, each of a form approved by the Industrial Commission of Ohio.

Rule 10.—No cores shall be blown out of castings by compressed air unless such work is

done outside the foundry or in a special or dustproof enclosure approved by the Industrial Commission of Ohio.

Men employed in cleaning castings by compressed air or sand blast shall wear eye guards and helmets; such helmets shall be of such designs as to meet the approval of the Industrial Commission of Ohio.

Rule 11.—Where fumes, gases and smoke are emitted from drying ovens in such quantities as to be detrimental to the health or eyes of the employes, hoods and pipes or exhaust fans or other mechanical means shall be provided over the doors of such ovens. Hoods and pipes will not be required where they would interfere with the operations of traveling cranes, but other effective means shall be provided for the removal of such fumes, gases and smoke.

Lighting and Heating

Rule 12.—Where natural light is insufficient properly to light the foundry, artificial light of sufficient power shall be provided, in the discretion of the Industrial Commission of Ohio.

The continuous use of hand torches or other lamps that emit injurious smoke or gases is prohibited.

Rule 13.—Interior walls of foundries shall be whitened, at the discretion of the Industrial Commission of Ohio.

Rule 14.—Proper and sufficient heat shall be provided and maintained in every foundry. The use of the open salamander stove, or stoves of that type, when used for heating purposes shall be prohibited. Open fires may be used for the purpose of drying molds or cores, if coke containing less than 1 per cent of sulphur be used.

Rule 15.—All hands and bull-ladles shall be dried outside the foundry, or in accordance with Rule 7.

A sufficient number of sheet iron shields shall be available in foundries for use in covering hand and bull-ladles.

Sanitary Conveniences

Rule 16.—Suitable facilities shall be provided for drying the clothing of such employes as may be found necessary at the discretion of the Industrial Commission of Ohio, and may be located in the wash room, the locker room, or in a room used exclusively for that purpose.

Rule 17.—In every foundry where water closets or privy accommodations are permitted by the Industrial Commission of Ohio to remain outside of the foundry, the passageway leading from the foundry to the said water closets or privy accommodations shall be so constructed that the employes in passing thereto or therefrom shall not be exposed to outdoor atmosphere, and such passageways, water closets and privy accommodations shall be properly heated during cold weather.

Rule 18.—Water closets shall be provided in every foundry and for each sex according to the following table:

Number of Persons	Number of Closets	Ratio
1 to 10	1	(1 for 10)
11 to 25	2	(1 for 12½)
26 to 50	3	(1 for 16⅔)
51 to 80	4	(1 for 20)
81 to 125	5	(1 for 25)

For every unit of 45 or fractional part thereof in excess of 125 persons employed, one additional water closet shall be provided.

Rule 19.—In every foundry there shall be provided one urinal; where more than 30 and less than 80 males are employed, two urinals shall be provided, and thereafter one additional urinal shall be provided for every 80 males employed of fractional part thereof. At least 2 linear feet of trough or slab urinal shall be considered the equivalent of one urinal.

Washing Facilities and Wash Rooms

Rule 20.—Wash basins with faucets for hot and cold water shall be supplied according to the following table:

Number of Persons	Number of Wash Basins	Ratio
1 to 8	1	(1 for 8)
9 to 16	2	(1 for 8)
17 to 30	3	(1 for 10)
31 to 45	4	(1 for 11¼)
46 to 65	5	(1 for 13)

For each additional 25 employes at least one additional wash basin shall be provided. Twenty inches of sink shall be considered the equivalent of one wash basin.

Rule 21.—Washrooms hereafter installed where 20 or more men are employed shall be provided with at least one shower bath with an ample supply of hot and cold water, and for every additional 100 men one additional shower bath shall be provided.

This rule shall apply to existing foundries at the discretion of the Industrial Commission of Ohio.

Rule 22.—Individual lockers, arranged for locking, shall be provided for employes, and shall be placed either in a room used exclusively for that purpose, in the washroom, the drying room, or at convenient places in the molding room. The necessity for individual lockers, numbers, etc., shall be determined by the Industrial Commission of Ohio.

Maintenance

Rule 23.—The floor beneath and immediately surrounding the cupola shall slope and drain away from the base of same.

Rule 24.—Persons tapping or stopping-up cupola must wear goggles to protect the eyes.

Rule 25.—Ladles, shanks, tongs, slings and yokes, skimmers and slag holes used in the pouring of molten metals shall, prior to their use, be inspected daily as to their safety, by the men preparing and using same, and in addition a regular inspection as to their safety shall be made once a month by a man designated for that purpose.

A monthly inspection shall also be made of the chains and cables on counterweights in connection with drying ovens, and reports of such inspections shall be made on forms prescribed by the Industrial Commission of Ohio, and shall be kept on file for its inspection.

Rule 26. — Trunnions on flasks hereafter constructed shall be carefully designed for the loads they are to handle, and constructed with a factor of safety of at least ten, including bolts where they are used. The diameter of the button shall be equal to the diameter of the groove plus one and one-half times the diameter of the sling used to handle the flask. Inside corners shall be well filletted and in order to prevent the sling slipping off or riding the button, the radius of the corner between groove and button shall be approximately equal to the radius of the sling used, the remainder of the inside edge of the button to be straight.

Rule 27.—All fireways or pits connected with drying ovens, when built in the floor, shall at all times be protected by either a substantial protecting cover or a standard guard rail.

Rule 28.—All trap doors shall be guarded when open, either by standard guard rails or watchmen, and all pits shall be properly covered or railed when not in use, and sufficiently guarded at other times. All casting pits must be free from water and abnormal dampness.

Rule 29.—All passageways and stairways shall be properly lighted, and inclined runways and stairways, charging decks and platforms shall be guarded with rails conforming to the standards of the Industrial Commission of Ohio.

Rule 30.—All ladles pouring from the lip, of 2,000 pounds or over capacity, shall be equipped with a worm-geared device for tilting same.

All crane, truck and trolley pouring ladles shall be so constructed that the center of gravity shall be below the bail, and shall be equipped with a clip to prevent the overturning of same.

Rule 31.—The use of high explosives is absolutely prohibited on the foundry premises, unless effective protection is provided.

Rule 32.—The breaking of castings by the use of a drop inside the foundry during the general working hours is prohibited.

When a drop is used for the breaking of castings or scrap outside of the foundry, a permanent shield of heavy planking or other protection shall be provided.

Rule 33.—Every employe in every foundry shall use the devices furnished for his protection by his employer, where there is a hazard connected with his employment.

Regulations for Coremaking Rooms in Which Women are Employed

Rule 34.—Where rooms in which core ovens are located adjoin rooms where cores are made by females and where the making of cores and the baking of cores are simultaneous operations, the partition between such rooms shall be constructed of concrete, hollow tile, brick, metal, or wood covered with metal, or other materials approved by the Industrial Commission of Ohio, and there shall be in such partition only such openings as are required by the nature of the business.

Rule 35.—All openings in partitions between the oven room and the room in which the females are employed shall be vestibuled with either a revolving device or double doors which shall be self-closing, or any other self-closing device equally effective, which shall be approved by the Industrial Commission of Ohio. Such devices shall be kept in such a condition that gases, fumes and smoke shall be effectually trapped.

Rule 36.—No female employed in any coremaking room shall be permitted to handle cores which have a temperature of more than 110 degrees Fahr.

Rule 37.—No female employed in any coremaking room shall be permitted to make or handle cores when the combined weight of core, core box and plate at which she is working shall exceed 15 pounds.

Brass Foundries

Rule 38.—A brass foundry is a place where brass, aluminum, copper, tin, zinc, gold, silver or composition metals containing any of the foregoing metals are melted or poured into sand molds in the making of castings. Foundries where aluminum only is melted shall be covered by the rules governing iron and steel foundries.

The term "cellar" when used in these rules shall mean a room or part of a building which is one-half or more of its height below the level of the curb on the ground adjoining the building (excluding areaways).

The term "basement" when used in these rules shall mean a room or part of a building which is one-half or more of its height above the level of the curb.

Rule 39.—The rules relative to dust, smoke, gases or fumes, ventilation, sanitation, heat, light, gangways and aisles, safety appliances, cleaning rooms, wash rooms, drying and locker accommodations, as specified for iron and steel foundries, shall apply to brass foundries, ex-

cept that main gangways shall be not less than 4 feet wide and gangways between molds on spill troughs shall be not less than 3 feet wide.

Where trolleys are used over molding floors for pouring metal, the aisles shall be of sufficient width to permit the safe ingress and egress of employes and the safe use of the ladles.

Rule 40.—When the crown plate of an upright melting furnace is elevated above the surrounding floor in excess of 12 inches, the furnace shall be equipped with a platform with a standard rail; such platform shall be constructed of metal or other fireproof material, and shall extend along the front and sides of the furnace, flush with the crown plate, and shall be at least 4 feet in width and shall be clear of all obstructions during pouring time. If the platform is elevated above the floor in excess of 12 inches the lowering from same of crucibles containing molten metal shall be by mechanical means.

Where the combined weight of crucible, tongs and molten metal exceeds 100 pounds, the same shall be removed from furnace and deposited on the floor by mechanical means.

Rule 41.—When smoke finish is desired on molds made on benches or tubs, smoke boxes which shall effectually trap the smoke shall be used, such boxes to be connected with flues to the outer air.

Rule 42.—Where molders work side by side at least 5 feet of space sideways shall be allowed for each man, and a clear space of 3 feet shall be provided back of each man.

Rule 43.—Hoods shall be provided directly above all skimming-blocks and brass melting furnaces using gas or oil as fuel, which will effectually trap all gases and fumes generated in the melting of the metal; these hoods shall be provided with outlet pipes to lead the gases and fumes to the outer air.

Ventilators shall be provided over all other furnaces used for melting brass or composition metal, to effectively remove the gases above the furnaces.

Rule 44.—Brass foundries shall be provided with natural light from at least two sides or from at least one side and skylights in the roof.

Protection From Molten Metal.

Rule 45.—All persons removing pots containing molten metal from furnaces and handling same shall be provided with protection for legs and feet.

Rule 46.—Gangway dirt and floor scrapings shall not be riddled in the room where workmen are employed, unless it is so dampened as to prevent dust arising therefrom.

Rule 47.—Stoves used for drying molds, when located in the rooms used by workmen, shall be surrounded by a casing of fire-proof material, to the full height of the stove.

Rule 48.—No brass foundry shall hereafter be constructed with a clearance of less than 14 feet between the lowest point of the ceiling and the floor, except that where a peak, saw-tooth, monitor or arch roof is constructed the side walls may be of a minimum height of 12 feet.

Rule 49.—No foundry shall hereafter be located in a cellar unless the ceiling shall be at least 14 feet in height measured from the surface of the finished floor to the under side of the ceiling; and if the foundry is located or intended to be located in the front part of the building, unless the ceiling of the foundry shall be in every part at least 6 feet 6 inches above the curb level of the street in front of the building; or, if the foundry is located or intended to be located in the rear part of the building, or to extend from the front to the rear, unless the ceiling shall be not less than 3 feet above the curb level of the street in front of the building, and the foundry shall open on a yard or court which shall extend at least 6 inches below its floor level; nor unless proper and adequate provision shall be made for lighting and heating.

Rule 50.—In case any foundry that was legally operated in a cellar or basement on Jan. 1, 1916, shall be discontinued or unused for a period of more than four consecutive months, it can thereafter be reopened as a foundry only by complying with the provisions of the rules relating to future foundries.

The occasional operation of a foundry for the purpose of evading this rule shall not be deemed a continuance of use thereof.

Safety First for the Side-Blow Converter

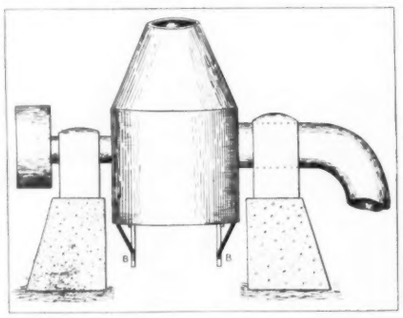
By Fred West

NOTWITHSTANDING the fact that many items of foundry equipment, such as cupolas, converters, flasks, etc., are standard, it is common to see changes made in some detail or other in nearly all foundries. Individual kinks that are improvements according to the notions of the superintendents and foremen are sure to be made. One great advantage of applying these is that the personal interest of the men for the equipment is increased, and thereby the efficiency of the plant. It is the kind of a personal equation that counts.

Sometimes the change consists of taking off some useless part or attachment, usually for the reason given that the item is "a trouble maker," or maybe "we can't use it with our men," or "my own rig is much better," etc.

While the change often consists in removing something, yet the addition of useful home-made parts is quite common also. The accompanying sketch shows one of the additions that was adopted in a large foundry to prevent the repetition of an accident that seriously damaged a converter in the steel casting department.

The converter is mounted in the usual way on two foundation piers that are just far enough apart to allow the body of the converter to swing to a vertical position. The accident was caused from the bottom doors swinging so far and standing out to the limit when the converter was in a horizontal position. They then remained in this position while the converter was being swung through 60 degrees or more from the horizontal. The doors caught on the foundation piers, as the operator was at a distance and could not see the condition, and clocked the motion, resulting in a smash-up of the driving gear and the connections.



"SAFETY FIRST" KINK APPLIED TO A CONVERTER

The home-made, *safety first* remedy consists of the use of two simple braces, *B*. One is bolted to the back of each door, and they are arranged to strike the bottom of the converter and prevent the doors swinging farther than slightly beyond the vertical position.

Like all *safety first* kinks, this one has to be watched; for if it is trusted to the extent of never giving it any attention, any distortion or loosening from abuse or service may make it useless—or rather a source of danger. So if you would be safe, just look a "leetle out" at all times and never trust to your "forgetter," especially when in places where there is co-operation of labor.

Brylgon Steel Casting Co.

In the article published in the February issue of THE FOUNDRY, describing the plant of the Reading Steel Casting Co., Reading, Pa., it was stated that "Among the plants of that character is that of the Reading Steel Casting Co., Reading, Pa.; this corporation, which is the successor of the Brylgon Steel Casting Co., dates from 1906".

The Brylgon Steel Casting Co., which operates a plant at New Castle, Del., originally owned and occupied the property in Reading now occupied by the Reading Steel Casting Co., but in 1904 it removed to its present location in New Castle, having abandoned the Reading plant, which later was sold to the Reading Steel Casting Co. Therefore, the Reading Steel Casting Co. in no sense is the successor of the Brylgon Steel Casting Co. which makes a specialty of high-grade and difficult castings of carbon and alloy steels.

How Sheaves Are Molded in an English Shop

The Construction of the Patterns and Core Boxes is Outlined in Detail and the Molding Methods are Fully Described

By Joseph Horner

SHEAVE wheels occur in so large a range of dimensions and sectional forms that they entail various methods of production, including complete patterns, segmental patterns and cores. There is little in common between the pattern work and molding of a sheave a foot in diameter and one of eight or ten feet, between a plain casting with a disc center or one with cast arms, and one with wrought iron arms strutted. The following examples will illustrate the principal differences.

The typical plain sheave, center-plated or with arms, is shown in Fig. 1. The particular section of the rim is of no importance regarded from the point of view of the pattern-maker and molder. It varies with the chain or rope which has to lie in it. The one feature of importance is that it is a recessed casting which molds flatwise as it lies, and must have sand joints at *A* and *B*. Also, apart from the use of cores, the pattern must be jointed at *C* to permit of lifting the upper part of the pattern away in order to allow the annular ring of sand that lies between *A* and *B* to be lifted.

Constructing the Pattern

The method of construction and of jointing the pattern may be varied. The pattern is made of metal if for prolonged service; of wood if for a few scores, or even for 100 or 200 molds. Very small patterns can be turned in the solid from mahogany, and these will retain their shape for years if well protected with varnish. But all of over about 6 inches in diameter must be built up with segments, Fig. 2. If plated centers are required these also are built in segments the same as the rim. If ribbed arms are used these are locked together and let into the rim the same as patterns for gear wheels. Also, alternatively, the pattern may be jointed along the center at *A*, Fig. 2, or the web or arms may be in one thickness, which affords a stronger job, and the upper half of the rim may be left loose, as at *A-B*, Fig. 2.

If metal patterns are used either of these methods is adopted, as shown in Figs. 3 and 4. Generally, too, the bosses are wood and are loosely studded to the web or the arms. If vertical ribs are fitted to arms the bosses are screwed to the flat arms, and the ribs to both, Fig. 5, thereby making a stronger pattern of a naturally flimsy one.

Many sheaves are similar to those of pulleys, either singly or doubly curved, instead of flat and vertical arms forming a cross-section. One of these is shown in Fig. 10. These patterns can be made of iron only, the grain, if cut from wood, being too

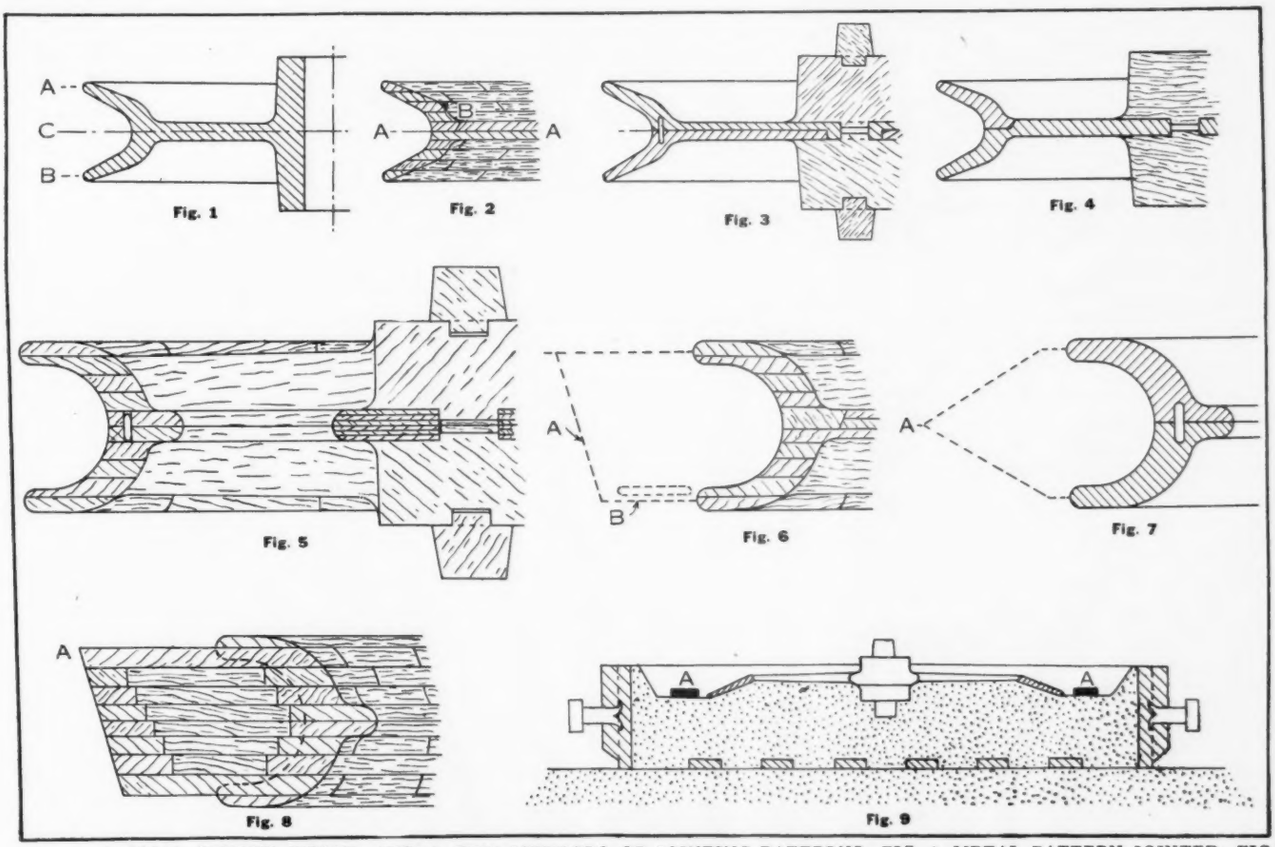


FIG. 1.—TYPICAL SHEAVE WHEEL; FIG. 2, TWO METHODS OF JOINTING PATTERNS; FIG. 3, METAL PATTERN JOINTED; FIG. 4, ALTERNATIVE METHOD OF JOINTING; FIG. 5, PATTERN JOINTED THROUGH CENTER; FIGS. 6 AND 7, JOINTING IN A TWO-PART FLASK; FIG. 8, PATTERN RIM MADE FOR CORING; FIG. 9, DRAG RAMMED, READY FOR COPE

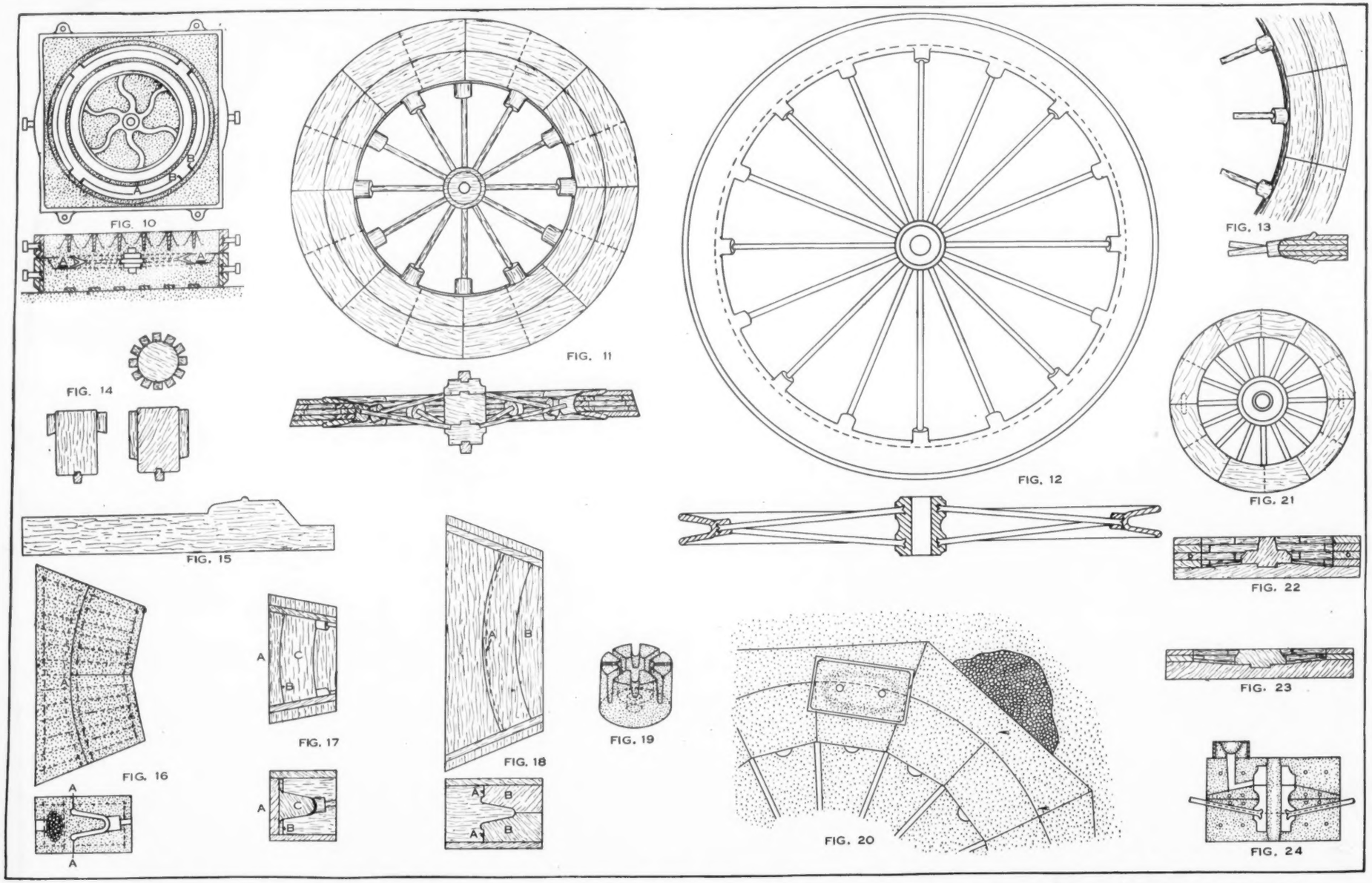


FIG. 10—METHOD OF MOLDING A SHEAVE WHEEL; FIG. 11, PATTERN FOR WROUGHT IRON ARMS; FIG. 12, LARGE SHEAVE WITH WROUGHT IRON ARMS; FIG. 13, SEGMENTAL PATTERN; FIG. 14, PATTERN BOSS; FIG. 15, SWEEP BOARD; FIG. 16, RELATION OF INNER AND OUTER CORES; FIG. 17, CORE BOX FOR INNER CORES; FIG. 18, BOX FOR OUTER CORES; FIG. 19, BOSS CORE; FIG. 20, PART PLAN OF RIM MOLD; FIGS. 21 AND 22, CORE BOX FOR OUTER PORTIONS OF BOSS; FIG. 23, CORE BOX FOR INNER PORTION OF BOSS; FIG. 24, CORES FOR BOSS MOLD

short to stand severe service. Pulleys of large diameter must have arms of wrought iron, cast arms being liable to break.

Usually a sheave pulley is made in a three-part flask, the joints of which coincide with the joints *A* and *B*, Fig. 1. However, a two-part flask can be employed if the parting is made as shown in Fig. 6. This entails the making of a sloping sand joint at *A* and an annular grid ring must be located at *B* to carry the ring of sand which forms the concavity of the sheave, so that more work is thrown upon the molder than when a three-part flask is used. Another method of jointing is shown in Fig. 7, the joints being sloped to meet at *A*, which corresponds with the joint of the two-part flask. In this case, also, the ring of sand must be lifted on an annular grid, and more trouble has to be taken to make the sloping joints than plain ones.

Solid Patterns

Sometimes patterns are made solid, Fig. 8, and the throat is cored round. One mold joint only, at *A*, then is required. But the cost of coremaking much more than offsets the advantage gained, and the method is only properly used in two cases. The first is when a sheave is molded from a ring pattern, or from a segmental pattern, or with cores, in each of which the center has wrought iron arms. The second is when a casting has to be made from a mold taken from an existing solid casting.

The bosses are fitted as shown in Figs. 3, 4 and 5, with central studs, whether the pattern is made in wood or metal. Bosses are thus self-centering and interchangeable to suit the different bores that may be required from time to time.

Figs. 9 and 10 illustrate the method of molding a sheave pulley which might range from 2 to 3 feet in diameter, over which size wrought iron arms are frequently preferred. It is shown as made in a two-part flask by the method indicated in Fig. 6. The pattern is made of iron and is jointed. The jointing may be done symmetrically, that is, through the center of the arms and rim as in Fig. 3, or the half rim above may be loose, as in Fig. 4. Either is adopted as often as the other. A slight advantage of jointing through the arms is that the molder has the plane face as a guide for making his joint. An advantage of the unjointed arms is that the pattern is less liable to become fractured than it is when the arms are in two thicknesses.

To mold this, a half pattern is first roughly bedded in loose sand by its joint face, sufficiently firm only to permit the joint parting to be made along the middle of its flange. On that joint the drag or bottom part is rammed and turned over to bring the joint face uppermost, Fig. 9. Before the cope is put on, a sloping, annular joint is made as shown, reaching up to the joint face of the flask, to form the joint for the ring of sand which is to take out the groove. After shaking on the parting sand, an iron ring, *A*, is bedded down on the longitudinal joint face. It has lugs cast-in, Fig. 10, by which it is both set and returned into place and by which it is lifted. Eyes might be cast-in for the latter purpose, but they are not necessary. Iron stakes are driven in alongside the edges of the lugs as guides for the correct return of the ring into place. The mold is rammed to the joint face and nails are laid in to carry the overhanging sand in the groove. The top half of the pattern is next laid on the lower half and the ramming is continued up to the joint at the middle of the convex edge, Fig. 10, and is sleeked off level with the box joint. The cope is now put on, rammed and lifted and the top half of the pattern is drawn. Hooks are inserted under the lugs on the ring, *A*, portions of sand being dug away for the purpose, and the ring of sand is lifted away. The lower half of the pattern being thus exposed is now withdrawn, the mold cleaned and the ring and cope returned to their places, the complete mold being illustrated in Fig. 10.

Sheaves With Wrought Iron Arms

Sheaves with wrought iron arms also are made from complete patterns. The patterns used may have the central boss connected with the rim by continuous prints of the same size as the arms, Fig. 11. In the largest wheels the boss is separate from the rim and short prints only are fitted to each. The disadvantage of this is that the boss has to be molded and centered separately from the rim. The wrought iron arms are only set and enclosed by sand at their ends.

Fig. 12. illustrates a pulley of large dimensions such as would be used for a pit-head gear. Fig. 13 shows the pattern segment required if that method of making it were adopted, and Fig. 14 one design of pattern boss, plain and straight throughout. But Fig. 12 has another design recessed and lightened about the center. This apparently slight difference in shape entails different ways of working. In the first case the boss is rammed distinct and separate from the rim, and is set in its place centrally and in relation to the plane of the rim by measurement. In the second case the boss is formed in four separate cores.

Ramming the Rim

The method of ramming the rim in Fig. 11 is either by rolling-over or by bedding-in. Fig. 13 is bedded-in. The gorge in each must be cored. The outer joint faces are made to the top edge of the print, and the inner are sloped to follow the center planes of the prints for the wrought iron arms and their bosses. The work can be aided and lessened and a higher degree of accuracy insured by sweeping a bed with a board, Fig. 15, on which to lay the rim. Only the diagonal jointing along the middle planes of the arm prints and bosses will then have to be done by hand and trowel. But it would be so troublesome and tedious to employ a segmental pattern, Fig. 13, in a case like this that coring is preferable for the entire rim. It might be done by sweeping a top or cope as well as a bed, or by ramming a cope for a swept reverse mold. Then the segmental pattern would be worked round on the bed, and the jointing done in succession around the prints and bosses. Then around the bounding edges strips of brown paper moistened with clay water on the top would be laid and the cope lowered. On its removal the strips of brown paper would adhere to the cope and serve as guides for setting and laying on the segmental pattern for ramming and shaping the sand around bosses and prints. Other and better ways are to stick nails alongside the edges in the bottom leaving them standing up slightly to make their marks in the top; or, strips of thin hoop iron may be pushed in to stand up similarly. But in either case the jointing along the edges of the bosses will not be neat and flush. Hence the better method, when the cost of a full pattern rim, the same as Fig. 11, becomes too heavy, is to use cores only. This is practically the only way when sheaves range from 6 to 12 feet in diameter and when perhaps only one or two such castings are required.

To make a rim entirely in cores the method of coring indicated in Fig. 13 must be abandoned and that of Fig. 16 substituted. The reason is clear. The sweeping-up of a bottom and top bed corresponding with the cross-section in Fig. 13 must be avoided. It is not an impossible alternative, but it is too troublesome to be en-

tertained. Instead, in Fig. 16, a plain bottom and cope only is required, plane on each face, and no jointing at all has to be done along the centers of the arm prints and bosses. Instead of the jointing for the gorge between the core and the mold being done in horizontal planes it takes place in a vertical circular plane, Fig. 16, *A-A*. To provide ample sand space around the arm bosses the cores are made considerably deeper than the width of the rim, and by jointing them around the middle of the beading, the semi-circular shape of the bead is neatly produced.

The Cores

From the section, Fig. 16, which represents the cores made and abutted by the circular jointing plane, the method of making the core boxes will be readily understood. The relations in plan which the cores occupy to each other and to the rim are indicated in the upper part of Fig. 16. It will be noted that the inner cores are twice as numerous as the outer ones. This only happens so because it is desirable to joint every inner core along the center of an arm. But as no such limitation exists on the outer ones, they are made of a length just convenient for handling.

The two boxes are made with sides and radial ends drawn in. The inner faces of the ends coincide exactly with the radial jointing faces of the cores. The circular joints, meeting at *A-A*, Fig. 16, are made in the inner core box, Fig. 17, by the curved face, *B*, of the block, *A*. The corresponding joint of the outer box, Fig. 18, is produced by the curved face, *A*, of the blocks, *B-B*. The radii of these are obtained directly with trammels from the full-size drawing. The gorge of the pulley is cut in blocks, *B-B*, Fig. 18, which are drawn away laterally after ramming the core. The blocks may be screwed to the box sides, or maybe laid within them. Being flush along the bottom they cannot shift.

In the inner box, Fig. 17, the outside of the pulley is formed by the block, *C*, which is screwed to the block, *A*. A half boss and a half print for the arms are screwed on each end, each being set at different angles alternately to correspond with the strutting of the arms. They need not be changed for each core, but one-half set of the cores will be made first and the box then is altered for the remaining half. These cores have to be turned over when rammed. The sides are withdrawn first, then the blocks, *A* and *C*, are lifted out, and finally the ends are drawn away. Such cores are rammed on grids only when they are of very large dimensions. Ordinarily they can be lifted by hand. The only stiffening they require is that of rods rammed in round the curves and radially to support the sand, Fig. 16. When cores are fairly massive a small body of cinders is introduced into the thicker sections, Fig. 16, to assist in venting, but they are hardly necessary in the example shown. The cores are dried, then tried round the circle and against each other, and any slight corrections are made if such are necessary before blackening. They are set on a level bed surrounded with a middle flask between the sides of which and the outer cores, sand is rammed level with the tops of the cores, on which the cope is laid. But before covering up we must go back to the formation of the boss and the setting-in of the arms.

The boss may be either plain or recessed. It is easier to make it plain. If recessed, it must be rammed in three core boxes with their joints corresponding to the centers of the arms. If plain, the boss can be made in a core with drop prints to carry the arms. In both cases it has to be centered by measurement from the rim cores. In neither case is a flask required. The boss need be recessed only when pulleys are large and the strutting wide apart. Then if the boss were made parallel, the metal would be rather excessive in the center and become a source of weakness, being liable to draw.

Making the Plain Boss

For the plain boss a pattern boss must be made having drop prints. It can be rammed as a core within any circular box of sufficient diameter that happens to be available. In shops where pulleys are molded from cast iron rings one of these rings is conveniently selected to do duty as a core box. The core, Fig. 19, when dried is centered both radially and in relation to the plane of the rim cores, being leveled with a spirit level, and enough sand is rammed round it to retain it in position, coming up just as high as the lower arms. These are then laid in the print impressions in the inner rim cores and in the lower drop print impressions and stopped-over. The upper arms are dealt with similarly, and then sand is rammed round for a few inches, sufficient to prevent a run-out of the metal. Sand also is rammed next to the inner rim cores to secure them, but the intervening spaces can be left open.

Figs. 20 and 16 show the appearance of the mold in plan and in part section, respectively. Vents are brought from the inner ring of cores by ramming runner pins against them and withdrawing them. From the outer cores vent pipes are carried. A body of cinders surrounding them will assist the vents. The cores may be weighted or covered with a cope. The rim is poured several hours before the boss.

Recessed Boss

When the boss is recessed, as in Fig. 12, the upper, lower and the middle portions each are made in a separate core box. Figs. 21 and 22 show the box for the upper and lower portions of the core, Fig. 23 that from which two half middle cores are made and stuck together. Fig. 24 illustrates the relations of the cores. The construction of boxes and cores are too obvious to need comment. The meeting faces of the cores which carry the half thicknesses of prints must be sloped to the same angles as the arms. When dried, the lower one is set in as well as the lower set of arms. Then the middle one is placed over and the upper set of arms laid in and covered with the top core. Sand is then rammed around as in the previous case to maintain the cores in place and to prevent the escape of metal.

A few facts in connection with the pouring and venting remain. There are variations in methods, but the following remarks cover all the usual practice:

The rim is poured, as stated, before the boss and is allowed to cool to a black-hot state before the boss is poured. If this is not attended to, but if the two are poured at the same time, the shrinkage and inward movement of the rim will bend the arms or fracture the rim.

The rim is poured flatwise through one or two runners, and in large sheaves at two places on opposite sides.

The vents are brought out from the inner and outer sets of cores through openings provided. These may be vent pipes if cinders are rammed in the cores, or little channels if otherwise, which may be rammed around flat runner pins.

The boss is poured through a single runner. It is not necessary to cover the rim with a cope, but the cores may be loaded only. If so, they should be covered with flat plates over the joints and the weights placed on the plates.

Sanitation of the Brass Foundry Promoted by Proper Ventilation

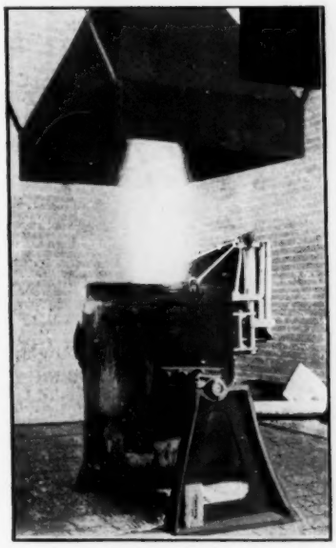


FIG. 1 — TILTING FURNACE PROVIDED WITH AN INDIVIDUAL HOOD

FIG. 2 — FOUNDRY STOVE WITH COUNTERWEIGHTED, SLIDING HOOD

BRASS foundry ventilation is discussed in a copyrighted bulletin recently issued by the Committee on Safety and Sanitation of the National Founders' Association, which constitutes also one of the interesting chapters of the volume, entitled "Safety in the Foundry", by Magnus W. Alexander, chairman of this committee, and issued under the auspices of this society. The subject of ventilation is discussed as follows:

"Foundry buildings usually are large and high, with a great amount of window space available for ventilation, and each foundry employe is provided with more floor area than is ordinarily alloted to workmen in many other occupations. The advantage of much working and breathing space, however, is offset in more or less degree by factors that tend to vitiate the air. The fumes thrown off from molten metals which contain zinc may injuriously affect the health of workmen. Much objectionable smoke sometimes arises from core ovens or from molds containing cores in those foundries where the amount and size of the cores is comparatively large. Fumes arise also from acids employed in the cleaning and pickling of castings. All foundries are also confronted more or less with the dust problem, which is particularly aggravated in cleaning departments and in sand-blasting rooms.

"For all of these conditions practical remedies have been found and put into service. This has been accomplished sometimes by effective natural ventilation, sometimes by a system of forced draft either for general ventilation or for the ventilation of individual rooms or particular furnaces or machines. Improvements in the combustion of fuel or the use of practically smokeless core binders has often eliminated the necessity for more than ordinary ventilation. Cleaning room floors of brick, concrete or wood blocks can be more easily kept free of excessive dust than floors made of clay; an occasional sprinkling of the floors helps materially to keep down the dust. In certain classes of work where it is impossible otherwise to secure satisfactory relief from fumes and dust, workmen are provided with respirators or other health protective devices. Natural ventilation is most frequently employed because it is most economical and in many cases fills all requirements. Open windows in the lower part of the building allow the entrance of enough fresh air to drive the impure air up and out through open windows usually located in the monitor. Where, however, the roof is comparatively flat, there is a tendency of smoke or steam to remain in low hanging clouds, even when the windows are open.

"In some cases the smoke developed in the foundry is so great that the amount of natural ventilation required for its removal creates drafts that are objectionable to workmen, especially on cold days. To overcome this difficulty, the heating apparatus is located alongside of small openings in the wall where the heated air intercepts and tempers the cool air as it comes into the building, or the lower windows are slanted so as to deflect incoming air upward, thus avoiding a direct draft on the workmen. Sometimes it is sufficient to open the windows during the pouring and smoky period only.

"In foundries in which metal is being poured several times during the day or where the pouring operation is practically continuous, smoke or steam is constantly generated, and measures are required to provide constant relief. The situation is usually met by the installation of a system of forced draft with openings so located as to discharge fresh air into the room, cool in summer and warm in winter, at about or a little below the breathing zone; of course, suitable outlets, usually located in the monitors, also must be provided.

"Where foundry operation develops unusual quantities of fumes, ventilating hoods are installed at specific points to supplement the general ventilation. These hoods are found particularly in connection with brass furnaces, core ovens and various kinds of heaters and

FIG. 3—TWO HOODS SERVE THREE FURNACES EACH

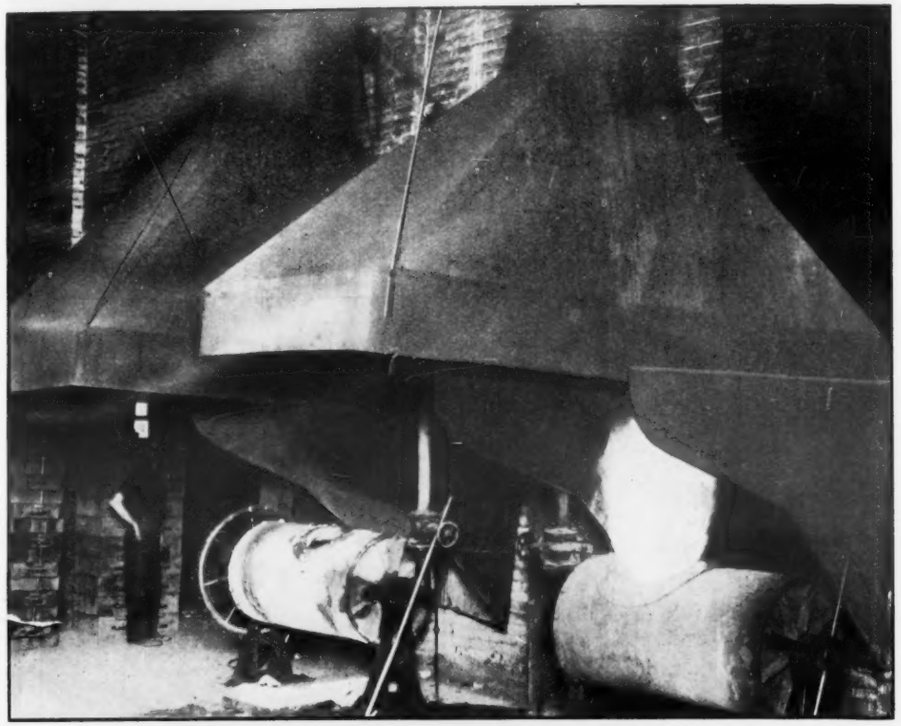


FIG. 4—FURNACES WITH INDIVIDUAL, RIGID HOODS

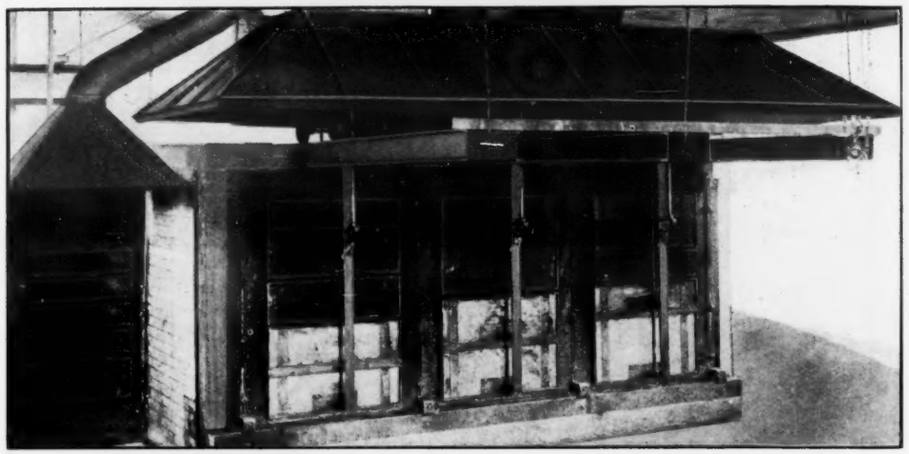


FIG. 6—CORE OVEN WITH HOODS WHICH CARRY OFF THE GASES WHILE THE CORES ARE BEING BAKED

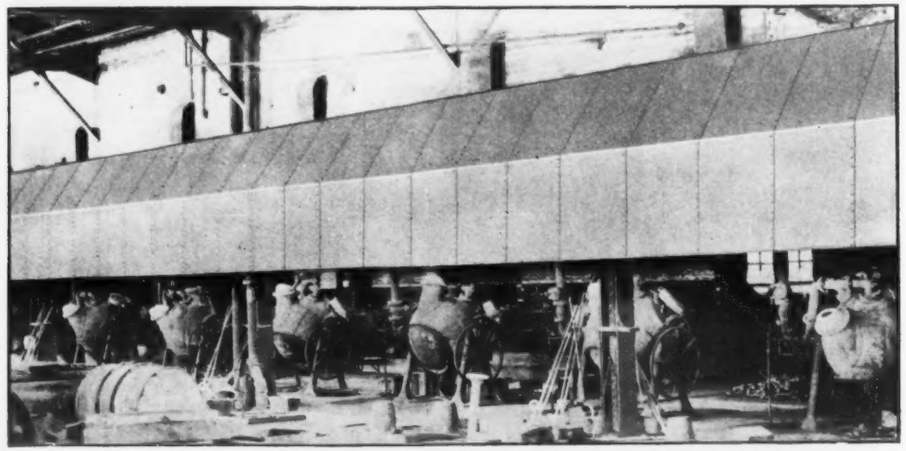


FIG. 5—BATTERY OF FURNACES SERVED BY ONE HOOD, BUT EACH FURNACE VENTILATED BY INDIVIDUAL STACK

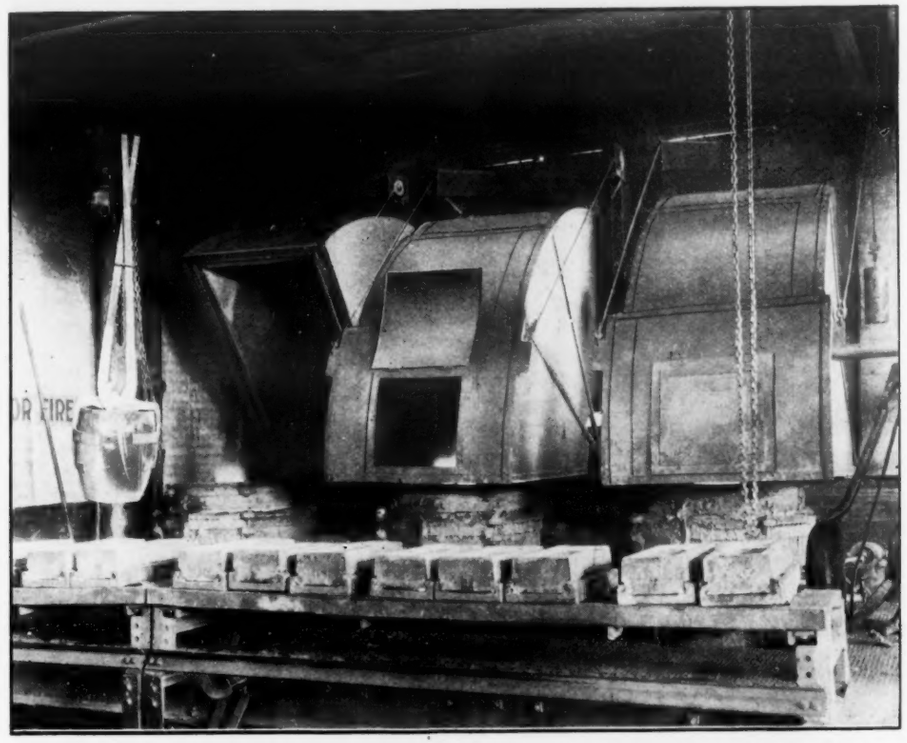


FIG. 7—STATIONARY FURNACES WITH INDIVIDUAL, TELESCOPIC HOODS

dipping tanks. In some instances each hood serves a single furnace, oven, heater or tank, while in others large hoods extend over groups of such apparatus. The individual type has usually proved to be most efficient. Figs. 1 and 4 illustrate individual hoods of simple design, suitable for use with brass furnaces of the tilting type. Fig. 7 illustrates three individual hoods, each of which is made in three sections. The wall section is rigid and is connected at its rear to an individual stack; when necessary, to make room for the use of a hoist for placing or removing crucibles, the other two sections, which telescope over each other and the rigid section, are raised out of the way. When lowered, the bottom sections of the hoods are close to the furnace tops and prevent the escape of fumes into the room. Fig. 3 illustrates two hoods of the group type, each of which serves three tilting furnaces; in this case the metals melted are low in zinc content, and the two hoods have proved adequate to keep the air free of objectionable fumes. Fig. 5 illustrates a hood serving a number of furnaces; each furnace, however, is provided with an individual stack. Fig. 6 shows hoods for ventilating core ovens.

FIG. 8—LADLE HEATER WITH HOOD

"In many cases, it has been found that the excessive smoke from core ovens was due to imperfect combustion of fuel oil, which in turn was caused by unsuitable burners or their improper adjustment. In coke or coal-fired ovens the difficulty has often been traced to flues that were faulty or limited in size or clogged with soot. The improvement in foundry ventilation resulting from attention to these simple details has been surprisingly effective. Fig. 9 shows two of the many hundreds of hoodless core ovens that have been rendered practically smokeless by securing proper combustion and draft. An important factor in the prevention of smoke from cores either while they are in the ovens or in the molds, is the character of the core binder in use. It is well known that flour, resin and some core oils abound in smoke producing elements. Many foundrymen have cleared their foundries and core rooms of this aggravating smoke nuisance by substituting for these materials readily available core binders that will not develop smoke to any great extent. The use of mechanical devices for mixing core sand with the binders also lessens the amount of smoke thrown off from cores, as the more thorough mixing requires a smaller amount of the binder; the less binder used, the less resulting smoke.

"Where, on account of the large size of the cores and the character of the castings, the objectionable smoke cannot be avoided, it has been found to be good practice to place such molds at one end of the foundry or even in a separate room and to pour the smoky molds last so as to isolate the smoky molds and confine the smoky condition to a short period at the very end of the day. Another cause of smoke in foundries lies in the practice of drying ladles by making wood fires in them. Modern practice obviates this smoke nuisance by the use of specially constructed ladle heaters for drying small ladles; one of these heaters is illustrated in Fig. 8. Large ladles, on the other hand, are dried in core ovens or in other well-ventilated places where the smoke will not foul the foundry air. Moreover, the amount of smoke in foundries is reduced by careful preparation of cupola fires and by thoroughly burning the wood kindling before applying the blast. Sometimes excessive fumes are caused by burning high sulphur coke or coal in salamander stoves, which are frequently used in foundry buildings for temporary heating purposes; even when low sulphur fuel is used, the gases may prove objectionable, especially to cranemen or others working in high positions. A proper hood placed over the salamander stove, as shown in Fig. 2, will take care of the situation. The chief advantage of this arrangement lies in the counterweighted, adjustable hood which slides up on the stack to permit feeding of fuel into the stove, but is afterward lowered to trap the gas and carry it out through the roof. Usually, a number of stove pipe openings are made in suitable places in the roof, each provided with a cover for use when the stoves are out of commission; in this way the salamander stoves can be moved to various places in the foundry and readily be connected with ventilating stacks. Especially good ventilation is required in dipping and pickling rooms to guard the health of workmen; this should not be neglected even though workmen wear suitable respirators. When the construction of these rooms is such that ventilation from open windows does not suffice, artificial ventilation is secured through the use of fans, either placed in wall or window openings or connected with ventilating hoods. The dust in the

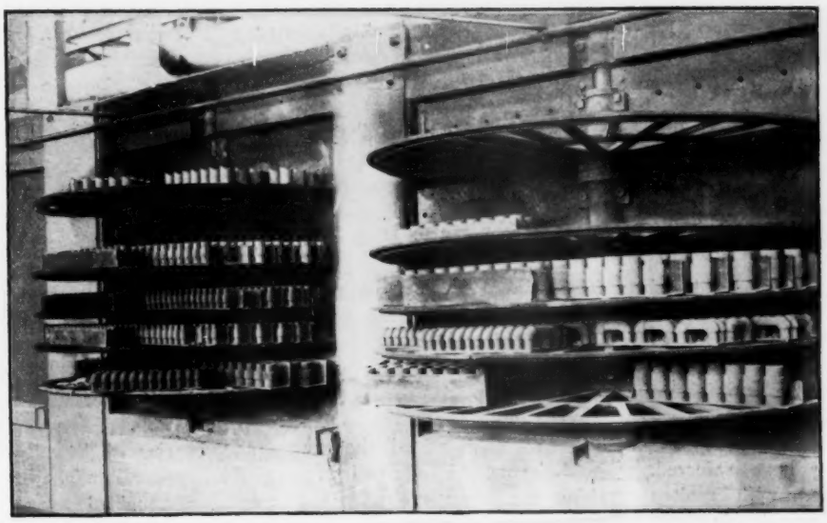


FIG. 9—CORE OVENS WITHOUT HOODS, YET PRACTICALLY SMOKELESS

foundry is an important factor in foundry ventilation. The dust is usually not objectionable in molding or core rooms, except in isolated instances where castings are poured only once or twice a week, and fine sand becomes dry meanwhile and floats as dust in the air. Occasional sprinkling of the floors provides a good and effective remedy. In cleaning rooms, on the other hand, dust presents a real problem that requires more serious attention. An excessive amount of dust is created here by the hand-cleaning of castings, the knocking out of cores and by mechanical cleaning operations, as in the tumbling machine process. The dust problem looms up most seriously in sand-blast rooms and here extraordinary means of ventilation are used; in addition, the health and safety of the operators are conserved by the use of special protective clothing and by the installation of equipment to safeguard health.

PROBLEMS OF THE BRASS FOUNDER

What To Do and How To Do It

Aluminum Solder

We have tried an aluminum solder recommended in the columns of THE FOUNDRY, *but we find that the bottom of the bar is very hard. It seems that the metal has not been mixed properly. Also, we would like to know how to dissolve beeswax for coating metal patterns. Kindly let us know whether to use benzine or gasoline.*

Regarding the failure of the aluminum solder to which you refer, it is probable that the various metals composing the alloy were not melted together in the proper manner, or probably one or more was oxidized in the melting process. Considerable skill is required in making alloys successfully even though the formula is known. Dissolve the wax in oil of turpentine in the proportion of one part of wax to four parts of oil of turpentine.

Flux for Melting Aluminum

We are melting aluminum scrap and the castings made therefrom are pitted throughout. We would like to know what flux to use to eliminate this difficulty.

In utilizing this scrap, first melt a small portion in the bottom of the crucible, add a small amount of salt to the bath and charge additional scrap until the bath becomes too cool to dissolve additional metal. Then make a further addition of salt and when the metal has attained a dull red heat, further scrap is added and this process is continued until the crucible is filled. At no time should any more scrap be added to the bath of metal than can be dissolved and under no conditions should the crucible be filled with scrap for the purpose of melting the entire charge at one time. This method never will give satisfactory results. This is a process which requires great care to avoid the pitting difficulty to which you have referred. After the pot is filled with molten metal, add a piece of zinc chloride about the size of a hazel nut and stir well to separate the dross from the metal.

Brazing Metal and Yellow Brass

We would like to have mixtures for a brazing metal, as well as for a good grade of yellow brass.

The following alloy will give good results for brazing:

Copper, 87 per cent; zinc, 12 per cent and lead, 1 per cent.

A good grade of yellow brass consists of the following:

Copper, 70 per cent; zinc, 26 per cent; tin, 2 per cent and lead, 2 per cent.

Pin Holes in Plunger Casting

We are making plunger castings 2 feet long, 8 and 10 inches in diameter and ¾ inch thick. When machined, pin holes develop. Ingot metal is used of the following composition: Copper, 85 per cent; tin, 5 per cent; zinc, 5 per cent and lead, 5 per cent; this is mixed with red brass scrap.

When melting add a small handful of rock salt to the metal in the crucible and keep the bath covered with fine charcoal, big lumps being of little use. When the metal is melted, add ½ pound of 15 per cent phosphor-copper.

Aluminum Alloy for Pistons

We would like to know the mixture of the aluminum alloy used by automobile manufacturers for making pistons. Also let us know whether this alloy is patented.

The following alloy will be found to be satisfactory and is not patented: In producing the alloy a hardner first should be made consisting of copper, 40 per cent; iron, 15 per cent, nickel, 5 per cent and aluminum, 40 per cent. This should be mixed thoroughly and should be run into small ingots. In making the alloy melt 93.50 per cent aluminum, to which should be added 6 per cent of the hardener. Stir well and do not permit the metal to get hotter than a dull red, when 0.5 per cent of magnesium should be stirred in.

The Use of Silicon-Copper

We have received an order for a large number of copper rings, 9 inches inside diameter, 11 inches outside diameter and about 3½ inches deep. We have tried to make these castings with mixtures containing phosphor-copper up to 2 per cent and silicon-copper up to 2 per cent. Invariably they are porous and when silicon-copper is used the castings contain considerable dirt. We realize the difficulty in casting silicon-copper which has been kept under a good cover of charcoal and 2 ounces of salt have been added to every 100 pounds of metal in the crucible. We also have endeavored to melt this under a cover of glass. Various methods of gating also have been tried, but the difficulty persists. These bands are rolled to a larger diameter and then are pressed hydraulically to the original diameter. Will 3 per cent of zinc added to the mixture affect the rolling properties, omitting the phosphor or silicon-copper? We realize that a mixture of this kind would cast similar to soft brass.

The best flux to use in making copper castings, in which the percentage of conductivity is not specified, is silicon-copper and no difficulty should be experienced in obtaining clean castings, regardless of the use of charcoal or some other good covering such as glass. Sound castings should be obtained by using 1 per cent of a 10 per cent alloy of silicon and copper. Thousands of pounds of silicon-copper are employed annually for making copper castings, practically all blast furnace tuyeres being made with copper deoxidized with silicon. However, since you have experienced difficulty in the use of silicon-copper it might be advisable to use zinc, although 3 per cent of zinc is rather high. We suggest adding the zinc in

the form of an alloy with copper in the proportion of one-half copper and one-half zinc. Use 4 per cent of this alloy, adding 2 per cent of zinc, and if the castings are not clean, add also 1 per cent of 5 per cent phosphor-tin.

Brass Rods for Acetylene Welding

Kindly publish the various mixtures used in making brass rods employed in acetylene welding.

Rolled rods of manganese bronze are extensively used in welding copper alloys with the oxy-acetylene torch and are satisfactory for many alloys, as manganese bronze melts and flows easily. For work requiring a red metal, an alloy consisting of 95 per cent copper; 2 per cent tin, and 3 per cent phosphor-tin may be used.

Trolley Wheel Mixture

Will you kindly give me a standard formula for trolley wheels for electric car lines?

An excellent alloy for trolley wheels consists of copper, 92 per cent; phosphor-copper, 2 per cent and tin, 6 per cent.

Formula for Architectural Bronze

We would like to have a formula for architectural bronze.

The following alloy is extensively used for work of the character stated: Copper, 89.5 per cent; tin, 7 per cent; zinc, 3 per cent, and lead, 0.5 per cent.

How to Melt Lead and Copper

We would like to know how to melt lead and copper to obtain an alloy of 39 per cent lead and 61 per cent copper and another alloy of 49 per cent lead and 51 per cent copper. We have had some of these castings made, which have been exceedingly porous and if they were not full of blow-holes, the lead and copper segregated. We would like to know how the metal should be melted and what flux should be used.

Numerous methods have been devised for holding lead in solid solution with copper. What is sought is an alloy which, when polished, will show no lead segregation and those who have succeeded in accomplishing this consider the secret a most valuable one. The method of retaining the lead in solution, in most general use, consists of adding sulphur to the alloy. Roll sulphur can be employed and the amount required will vary according to the degree of skill possessed by those making the alloy. It might be well to begin with ¼ of 1 per cent of sulphur, which is added to the copper when it is molten and before making the addition of lead. The amount of lead, when the latter is over 30 per cent, has little bearing on the problem, as 50 per cent lead can be retained as easily as 35 per cent and the same flux will serve in both cases. The copper first is melted under a flux of charcoal and salt, and when molten, the lead is added gradually, stirring the metal constantly. The addition of tin to harden the metal has a tendency to cause a separation of the lead and the copper in high lead-copper alloys.

Defective Bronze Bars

We are experiencing considerable difficulty in making a 4-inch bronze bar, 24 inches long. The mixture consists of copper, 86 per cent; tin, 6.5 per cent; zinc, 4 per cent; lead, 3 per cent, and phosphor-tin, 0.5 per cent. Our furnace is of the forced draft, coke-fired, tilting type and the metal is poured into clay-lined ladles before being cast into the molds. The castings are full of pin holes. When we first cast this bar it was poured on end without cope and while the casting was fairly sound, it contained pin holes at the center. Next, we made it with a cope, using a sprue 1 inch in diameter, poured from the bottom without riser and this casting was badly honeycombed. It was next poured in a horizontal position, the flask was tilted and horn gates were run into the bottom side and a large riser was used on the high end of the mold, but the casting was spongy at the center. The molds are all carefully dried and the metal is well-skimmed.

When melting the metal, use a flux consisting of powdered charcoal, black oxide of manganese and a little salt. This will prevent the absorption of sulphur from the coke and also will act as a deoxidizing agent. Since a small amount of the manganese will be reduced by the charcoal and will enter the alloy, use about 15 per cent of manganese oxide with the charcoal and employ a sufficient amount to keep the surface of the metal well covered throughout the melting operation. Do not add phosphor-tin to the mixture. The casting can be poured horizontally, or preferably inclined with a riser at the highest point and if the mold is painted with plumbago wash and then is skin-dried, a smoother casting will result. The riser should be larger in diameter than the bar so that it will solidify last and feed the shrinkage at the center. Do not make the error of pouring too cold.

Speed Boat Propeller Mixture

We would like to have a formula for speed boat propeller wheels.

The following alloy will be found satisfactory: Copper, 86 per cent; tin, 8 per cent; zinc, 4 per cent, and lead, 2 per cent.

Mixture for White Bronze

We would like to have a mixture for a white bronze, preferably one containing a small percentage of nickel, which must be hard, non-corrosive, which should machine easily and should be cast readily without such imperfections as pin holes. Any alloy that will have these properties will satisfy us, even though it does not contain nickel.

Try the following alloy: Copper, 59.5 per cent; nickel, 15 per cent; zinc, 25 per cent; aluminum, 0.25 per cent, and manganese copper, 0.25 per cent.

Mixture for Bronze Candlesticks

We would like a mixture for bronze candlesticks and bronze plaques.

An excellent alloy for plaques follows: Copper, 89 per cent; tin, 6 per cent; zinc, 3 per cent, and lead, 2 per cent. The same alloy also may be used for candlesticks if a red metal is desired. However, the following alloy probably will be more satisfactory: Copper, 76 per cent; zinc, 20 per cent; tin, 2 per cent, and lead, 2 per cent.

Antimony Prices

According to the United States Geological Survey, antimony prices in 1915 probably were the highest known since the metal became a regular article of commerce. It is estimated that the production of antimony ores in the United States last year approximated 5,000 tons, containing 2,000 tons of antimony valued at about $325,000. Antimony, which in July, 1914, had been down to a monthly average price of 7.11 cents for Cooksons and from 5.44 cents upward for other brands, advanced gradually to the end of 1915, when Chinese, Japanese and American antimony were quoted at about 40 cents a pound.

The U. S. Electric Lead Plating Co., 1265 West Second street, Cleveland, has been organized to engage in lead plating by the electric process. One of the specialties of this company will be lead-plated chaplets, which can be coated at a cost considerably below that of tinned chaplets.

Reclaiming Brass From Refuse in a Ball Mill

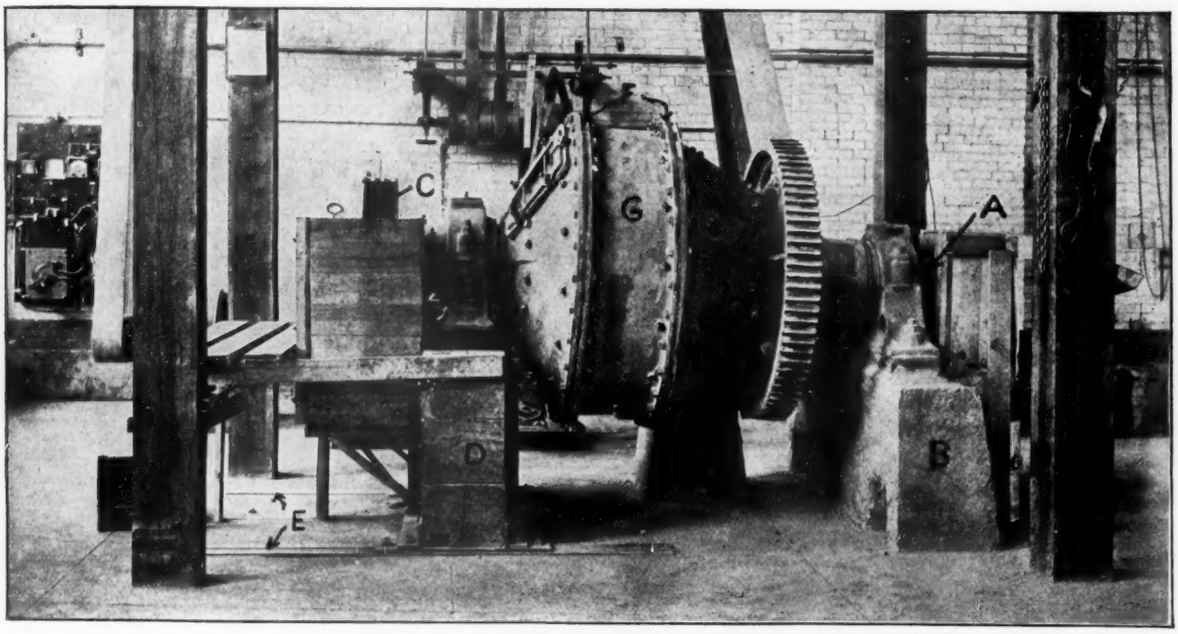
A Summary of Experiments on Grinding Brass Foundry Ashes, Slag and Sweepings—High Recovery Obtained, with Continuous Operation

By Arthur F Taggart and R W Young

IN THE manufacture of brass and brass products the weight of the finished material leaving the plant is much less than the total weight of copper and zinc entering. A small part of this discrepancy is due to the unavoidable oxidation of the metals in melting, but by far the largest part of the loss is in the form of metallic particles of copper, zinc and brass. These losses occur principally at three points in the process: in the casting-shop ashes; in the slags from furnaces melting scrap brass; and in material spilled on the floor throughout the manufacturing process. The amount of these products in some plants is nearly 100 tons per 24 hours.

Casting-shop or brass foundry ashes contain the metal spilled from the crucibles during melting and pouring, and the metal included in the slags formed in the melting process. The ashes also contain pieces of broken crucibles with adhering metal; 20 to 30 per cent of unburned coal is also present. The metal in casting-shop ashes contains clean pieces of zinc or copper ingots weighing 1 to 2 pounds, jagged pieces of metal of all shapes ranging in size from several inches down to the finest dust, and shot and botryoidal shapes ranging in size from 2 or 3 inches down to 0.1 millimeter or less in diameter.

Slags from furnaces melting scrap brass contain metal in the form of small shot. Floor sweepings occur in all shapes, spirals, thin shavings, pins and pin-like pieces, wire, rods, and buffing-wheel dust are the commonest.



HARDINGE MILL FOR RECLAIMING BRASS WASTE

In general the problem of reclaiming this metal has been to free the metal from adhering slag and separate it from the associated slag, coal and cinders. On its face this problem appears simple. That it is not simple, however, is attested by the concentrations of fine metallic particles in the sewers and stream beds of the New England brass-manufacturing districts. The usual plant installed has consisted of a crude hand-picking installation for recovering the coarse metal; a restricted-discharge grinder, such as the Huntington or Chilian mill, Krupp ball mill, cinder crushers, etc., for severing the metal from the slag; a concentrating table, usually a Wilfley, for treating the fine discharge from the grinder; and a settling tank for the slimes flowing away from the concentrating table. The coarse metallics are collected intermittently by stopping the plant and cleaning out the grinding machine. These plants are claimed to throw away tailings assaying but 0.5 per cent copper. Such statements probably are based on erroneous samples, for the tailings will, when the plant is properly sampled, be found to contain up to 5 per cent copper, and most of the coal frequently is wasted. In connection with the design of a plant for the treatment of brass ashes the writers were confronted with the problem of finding a grinder that would answer the following requirements:

Take a feed containing particles of metal 2 or 3 inches in diameter, with adhering slag, and at the same time pieces of slag containing metal shot in all sizes from the above down to the finest; discharge continuously both the metallic and non-metallic constituents of the feed, and thus eliminate the intermittent factor attendant upon the operation of the grinders previous-

A paper read at the New York meeting of the American Institute of Mining Engineers, Feb. 15, 1916. The authors, Arthur F. Taggart and R. W. Young, are connected with the Hammond mining and metallurgical laboratory, Sheffield Scientific School, Yale University, New Haven, Conn.

ly mentioned; discharge a product of such character that all the material larger than 2.5 millimeters is a clean metal, while all the slag and cinders are ground to pass the same screen; have a capacity of about one ton per hour; and have a reasonable repair and power charge. The following are the results of two tests run on a 4½-foot by 16-inch conical ball mill with these requirements in mind.

Description of the Test

The mill used in these tests was a special one built by the Hardinge Conical Mill Co. for testing purposes and installed in the Hammond mining and metallurgical laboratory, Sheffield Scientific School, Yale University. As shown in the accompanying illustration, the mill is mounted with the discharge end, *A*, on a fixed foundation, *B*. The feed end, *C*, is carried on the wooden pier, *D*, which can be slid parallel to the long axis of the mill and fastened in any desired position by holding-down bolts in the floor slots, *E*. The mill can be broken along the rims, *F*, and the cylinder, *G*, removed, thus giving a mill with no cylindrical section, or one, two, or three cylinders can be inserted making the cylindrical portion of the mill 16, 32 and 48 inches long, respectively, as desired. The mill is lined with chrome steel lifting bars. For the tests described herein, one 16-inch cylinder was used, making the mill the standard 4½ feet by 16 inches; the tilt was 2.5 inches toward the discharge end, the speed being 28 to 29 revolutions per minute. The ball charge was as follows:

Size of balls, inches.	Number of balls.	Weight, pounds.
5	100	1,927
4	100	951
3	205	815
1¼	1,002	720
		Total 4,413

Details of Tests

Two runs were made, which are referred to as No. 1 and No. 2 in the accompanying tables. In run No. 1 the feed was sluice concentrate, containing 30.01 per cent coal; it was fed at a rate of 2.24 tons solid per hour. The moisture in the feed was 42.9 per cent, and the power consumption was 20-horsepower. In run No. 2 the feed consisted of first and second gate discharges from jig, containing 1.23 per cent coal. It was fed at a rate of 0.91 ton solid per hour. The moisture in the feed was 39.7 per cent and the power consumption was 21-horsepower. Sizing-sorting-assay tests of feed and product of the two runs are given in Tables I, II, III and IV.

A concentrate can be made by simp-

Tests on Feed and Product

Table I.

SIZING-SORTING TEST ON FEED—RUN NO. 1.

—On screen— Aperture, Mm.	Wgt., grams.	Tons per 100 tons.	Cumulative per cent.	Assay, Cu, per cent.	——Tons per 100 tons—— Free metallic.	Slag.	Contained metallics.	Coal.	Per cent clean metallics in product on screen.
18.85	670.00	1.14	1.14	20.5	0.285	0.335	0.090	0.520	25.0
13.33	4,350.00	7.87	9.01	20.8	1.516	3.680	1.104	2.674	20.1
9.423	10,260.00	18.60	27.61	11.4	3.255	9.710	0.168	5.635	20.1
6.680	10,510.00	19.05	46.66	17.7	5.229	8.592	0.176	5.229	22.0
4.699	7,295.39	13.22	59.88	23.9	4.100	5.950	0.952	3.170	24.0
3.327	7,681.80	13.92	73.80	17.2	3.638	6.840	0.197	3.442	24.4
2.362	5,081.21	9.21	83.01	17.0	1.576	5.060	0.926	2.574	23.6
1.651	2,655.15	4.81	87.82	13.2	0.529	2.763	0.485	1.518	22.9
1.168	1,517.14	2.75	90.57	10.4	0.254	1.135	0.202	1.361	22.5
0.833	1,223.11	2.21	92.78	6.2	0.103	0.749	0.117	1.358	22.1
0.589	1,107.47	2.00	94.78	4.8	0.107	1.125	0.047	0.768	21.7
0.417	780.74	1.41	96.19	8.6	0.147	0.710	0.047	0.553	21.6
0.295	641.08	1.16	97.35	8.3	0.081	0.621	0.072	0.458	21.4
0.208	433.23	0.78	98.13	8.8	0.064	0.421	0.045	0.295	21.3
0.147	326.12	0.59	98.72	4.7	0.027	0.367	0.017	0.196	21.2
0.104	289.23	0.52	99.24	8.9	0.061	0.295	0.013	0.164	21.1
0.074	125.09	0.23	99.47	9.8	0.026	0.144	0.010	0.060	21.1
*0.074	292.95	0.53	100.00	10.6	0.085	0.354	0.005	0.091	21.1
†	80.29								
‡.....	55,320.00	100.00	.....	....	21.083	48.851	4.673	30.066	....

*Through. †Loss. ‡Totals.

Table II.

SIZING-SORTING TEST ON PRODUCT—RUN NO. 1.

—On screen— Aperture, Mm.	Wgt., grams.	Tons per 100 tons.	Cumulative per cent.	Assay, Cu, per cent.	——Tons per 100 tons—— Free metallic.	Slag.	Contained metallics.	Coal.	Per cent clean metallics in product on screen.
13.33	15.12	0.240	0.240	17.5	0.067	0.023	0.000	0.150	27.9
9.423	62.80	0.995	1.235	44.6	0.692	0.060	0.018	0.243	61.4
6.680	211.78	3.360	4.595	44.9	2.306	0.449	0.104	0.605	66.7
4.699	326.68	5.180	9.755	48.3	3.942	0.539	0.061	0.699	71.6
3.327	401.79	6.368	16.143	42.6	4.038	1.036	0.298	1.294	68.4
2.362	436.05	6.912	23.055	41.2	2.829	2.232	0.400	1.851	60.2
1.651	425.68	6.752	29.807	25.7	1.437	3.672	1.335	1.643	51.4
1.168	441.61	7.003	36.810	12.5	0.662	2.956	0.733	3.384	43.4
0.833	498.17	7.900	44.710	10.5	0.313	5.083	1.008	2.504	36.4
0.589	550.18	8.725	53.435	8.1	0.488	4.923	0.637	3.314	31.4
0.417	563.52	8.939	62.374	8.0	0.635	4.780	0.503	3.524	27.9
0.295	481.63	7.641	70.015	6.6	0.342	4.396	0.471	2.903	25.4
0.208	385.10	6.105	76.120	7.3	0.154	3.772	0.559	2.180	23.5
0.147	362.65	5.754	81.874	6.8	0.091	3.796	0.535	1.867	22.0
0.104	328.29	5.207	87.081	6.5	0.078	3.571	0.467	1.558	20.7
0.074	98.28	1.560	88.641	6.7	0.008	1.374	0.159	0.178	20.4
*0.074	715.80	11.359	100.000	9.3	0.011	8.829	1.672	2.519	18.1
†	104.88								
‡.....	6,410.00	100.000	.....	....	18.093	51.491	8.960	30.416	....

*Through. †Loss. ‡Totals.

Table III.

SIZING-SORTING TEST ON FEED—RUN NO. 2.

—On screen— Aperture, Mm.	Wgt., grams.	Tons per 100 tons.	Cumulative per cent.	Assay, Cu, per cent.	——Tons per 100 tons—— Free metallic.	Slag.	Contained metallics.	Coal.	Per cent clean metallics in product on screen.
26.67	323.00	7.810	7.810	55.9	6.285	1.525	0.698	.....	80.5
18.85	363.00	8.775	16.585	29.2	1.524	7.251	2.588	.....	47.1
13.33	1,065.00	25.757	42.342	25.8	6.045	19.591	5.425	0.121	32.7
9.423	1,088.00	26.307	68.649	31.6	8.340	17.846	4.970	0.121	32.6
6.680	720.00	17.420	86.069	36.1	7.257	9.800	2.808	0.363	34.2
4.699	380.00	9.189	95.258	42.9	5.200	3.747	1.115	0.242	34.6
3.327	91.33	2.210	97.468	43.5	1.219	0.896	0.320	0.095	36.8
2.362	28.16	0.681	98.149	43.9	0.380	0.267	0.098	0.034	36.2
1.651	19.91	0.482	98.631	37.6	0.221	0.246	0.069	0.015	37.0
1.168	9.90	0.239	98.870	32.7	0.098	0.125	0.026	0.016	37.0
0.833	6.27	0.152	99.022	25.7	0.033	0.102	0.030	0.017	37.0
0.589	6.00	0.145	99.167	21.4	0.025	0.096	0.024	0.024	37.0
0.417	4.58	0.111	99.278	17.1	0.018	0.068	0.013	0.025	36.9
0.295	4.86	0.118	99.396	15.3	0.015	0.077	0.013	0.026	36.9
0.208	4.63	0.112	99.508	10.7	0.001	0.084	0.018	0.027	36.8
0.147	4.73	0.114	99.622	10.5	0.002	0.079	0.018	0.033	36.8
0.104	5.00	0.121	99.743	7.4	0.001	0.084	0.014	0.036	36.8
0.074	2.73	0.066	99.809	9.1	0.001	0.051	0.008	0.014	36.7
*0.074	7.91	0.191	100.000	13.1	0.010	0.161	0.029	0.020	36.7
‡.....	4,135.01	100.000	.....	....	36.675	62.096	18.324	1.229	....

*Through. ‡Totals.

ly screening the discharge from the mill. The grade of this concentrate will depend on the character of the feed to the mill and the aperture of the screen used. Since brass containing more than 10 per cent dirt (slag and coal) is unsuitable for remelting, the concentrate obtained by screening the product from run No. 1 is not sufficiently clean. The product from run No. 2 can be screened on a 1.651 millimeter screen and will give a concentrate containing 90.9 per cent clean metal. If cleaner metal is desired, it can be obtained by using a screen of larger aperture.

The material passing the 1.651 millimeter screen in run No. 2 containing 13.9 per cent metal, is too rich to be thrown away, as is done in some plants, or to be sold to a junk dealer at a couple of dollars a load, as is done in some others. In run No. 2 about 25 per cent of the total feed to the mill, containing 70 per cent of the total metallic in the feed, can be saved clean enough for remelting without the use of concentrating machines.

A comparison of the sizing tests on feed and product of runs Nos. 1 and 2 show that finer grinding was done in run No. 2. This is due partly to the lower rate of feed and partly to the large percentage of coal in the feed in run No. 1. It will be noted in Table II that more than 50 per cent of the non-metallic material remaining on the 2.362 millimeters screen is coal. A comparison of results shows that the coal does not grind as freely as the slag.

Analysis of the data given shows that the metallics have been reduced in size from 6.08 millimeters to 3.62 millimeters, average size in run No. 1, and from 11.83 millimeters to 3.01 millimeters, average size in run No. 2. The reduction is not, however, so great as indicated, by reason of the fact that the largest pieces of metal were held back in the mill, the duration of the runs not being great enough for them to work through. The writers believe that the sharp increase in the percentage of minus 0.074 millimeter metallics in run No. 2 is due, not to sliming, but to the freeing of the included metallic from the slag, as was not done in run No. 1. This belief was borne out by an elutriation test, Table V, which showed no metallic in the finest sizes, and was confirmed by microscopic examination of the minus 0.074-millimeter material, which revealed the majority of the free metallics to be rounded, and not jagged as would be expected had they been abraded from the larger pieces.

The tables show the reduction in size of the slag in the two runs and the necessity of this reduction in order to free the metal. Microscopic examination of a slag particle, 0.1 millimeter in diameter revealed the presence of metal shot not more than 0.1 millimeter in diameter. In order to free these shot for concentration the greatest possible reduction of the slag is essential.

The reduction in size of coal is not so great in run No. 1 as in run No. 2. In both cases, however, the bulk of the coal will pass a 1-millimeter screen, and is, therefore, too fine for burning economically without special appliances. Its value to the plant is much less than if it were removed from the ashes before grinding.

Conclusions

The 4½-foot by 16-inch conical ball mill, operated as described in run No. 2, if fed a dirty brass concentrate containing slag and a little coal, at the rate of one ton per hour, will grind the slag and coal or coke so that a great part of it will pass a 1.651-millimeter screen while the brass in the feed will be only slightly reduced in size and can be separated from the dirt by screening. The screening operation can be performed by attaching a trommel of the proper aperture to the discharge end of the mill.

If the feed to the mill contains a considerable percentage of coal, the product saved on the screen will contain more than 10 per cent dirt. The writers believe that this will be true even if the feed rate is considerably below one ton per hour.

As compared with other types of machine at present being used for

Tests on Feed and Product

(Continued)

Table IV.

SIZING-SORTING TEST ON PRODUCT—RUN NO. 2.

—On screen— Aperture, Mm.	Wgt., grams.	Tons per 100 tons.	Cumulative per cent.	Assay, Cu, per cent.	——Tons per 100 tons—— Free metallic.	Slag.	Contained metallics.	Coal.	Per cent clean metallics in product on screen.
9.423	79.00	1.316	1.316	62.5	1.316	0.000	0.000	0.000	100.0
6.680	233.00	3.881	5.197	61.8	3.827	0.054	0.014	0.000	99.0
4.699	374.00	6.229	11.426	61.3	6.075	0.138	0.040	0.016	98.3
3.327	308.50	5.138	16.564	56.4	4.382	0.703	0.248	0.053	94.3
2.362	328.50	5.475	22.039	57.7	4.850	0.592	0.205	0.033	92.9
1.651	248.00	4.131	26.170	53.1	3.310	0.686	0.197	0.135	90.9
1.168	183.90	3.063	29.233	45.8	2.080	0.875	0.168	0.108	88.4
0.833	175.90	2.930	32.163	36.3	1.399	1.387	0.302	0.144	84.7
0.589	243.90	4.066	36.229	20.2	0.960	2.721	0.352	0.385	77.8
0.417	308.00	5.132	41.361	12.5	0.553	3.837	0.477	0.742	69.5
0.295	428.10	7.135	48.496	9.3	0.215	6.024	0.841	0.896	59.7
0.208	432.80	7.211	55.707	8.6	0.213	5.880	0.784	1.118	52.4
0.147	460.80	7.680	63.387	10.7	0.233	6.338	1.085	1.109	46.1
0.104	507.00	8.446	71.833	9.9	0.183	7.222	1.163	1.041	41.4
0.074	299.30	4.987	76.820	11.5	0.161	4.262	0.756	0.564	38.5
*0.074	1,393.20	23.180	100.000	11.5	4.265	17.067	.....	1.848	34.0
†	206.10								
‡.....	6,210.00	100.000	.....	....	34.022	57.786	6.632	8.192	....

*Through. †Loss. ‡Totals.

Results of Elutriation Test

Table V.

ELUTRIATION TEST ON MINUS 0.074 MILLIMETER MATERIAL, PRODUCT OF RUN NO. 2.

Current Mm. per sec.	Weight, grams.	Tons per 100 tons original product.	Per cent.	Cumulative per cent.	Assay Cu, per cent.	Tons per 100 tons of original product. Metallic.	Slag.	Coal.
9.5	0.45	0.241	1.09	1.09	51.1	0.197	0.044	0.000
5.1	2.80	1.499	6.80	7.89	23.5	0.563	0.936	0.000
4.2	1.67	0.896	4.06	11.95	9.0	0.130	0.766	0.000
3.2	4.25	2.273	10.32	22.27	12.1	0.440	1.833	0.000
2.3	3.65	1.955	8.87	31.14	10.0	0.313	1.617	0.025
1.5	3.87	2.071	9.39	40.53	9.6	0.317	1.547	0.207
0.9	4.99	2.672	12.13	52.66	9.8	0.419	1.932	0.321
0.6*	9.09	4.869	22.09	74.75	9.9	0.771	3.528	0.570
A	10.12	5.435	24.67	99.42	10.4	0.905	3.929	0.601
B	0.24	0.128	0.58	100.00	0.0	0.000	0.095	0.033
Totals	41.13	22.039	100.00	.....	....	4.055	16.227	1.757

*The discharge from the elutriation apparatus with 0.6 millimeter per second current was led into the bottom of a 2-liter wide-mouth bottle. A siphon dipping about 1 inch into the neck of this bottle carried the fine slime to other bottles rigged up in the same way. After standing several hours the supernatant liquid in these bottles was decanted and evaporated to dryness giving the product marked *B*; the material which settled in all but the first bottle is marked *A*. The material which settled in the first bottle is that opposite the 0.6 millimeter per second current.

grinding brass ashes, the conical ball mill should show a decreased repair cost, since screens are eliminated, and it has a further advantage in that it discharges continuously not only the ground slag and coal or coke but also the cleaned metal. The metal is not slimed in the mill, but that which is not caught clean on the screen is of such size that it can be easily saved by proper table treatment. While the basis for the conclusion does not appear from these tests, the writers have found in other work along similar lines that with the mill horizontal the metal is not cleaned up and the larger pieces of metal will not discharge from the mill.

The Use of Ferro-Titanium in Cast Steel

IN A 110-page book, entitled "Ferro Carbon-Titanium in Steelmaking", recently issued by the Titanium Alloy Mfg. Co., Niagara Falls, N. Y., an exceedingly interesting chapter on the use of this metal in steel castings points out how many of the defects can be eliminated. It is stated that the cracks sometimes can be attributed to molding conditions, since in cooling, the steel will contract and there is a point where it has lost its fluidity and is more or less viscous. If any resistance is offered to the metal during cooling, cracks inevitably are formed. In the case of over-oxidized metal, at the range of temperatures where viscosity is manifest, the tendency to tear is increased and a greater number of cracks will be found than in ordinary, deoxidized steel.

Unsoundness in Cast Steel

Unsoundness in steel castings usually is manifest in the form of blow-holes of varying formation. Shrinkage holes, due to the contraction of the metal during cooling can be taken care of properly by sink-heads. Blow-holes may exist all through a casting or near the surface only. They are due to the presence of gas and their shape may be oblong, lenticular or spherical. If oblong, they usually are due to the metal being incompletely deoxidized or *killed* in which case they will be found near the surface. If globular or spherical, they are caused by the presence of vapor, or air, and not by a chemical reaction taking place in the metal during its solidification in the mold. The latter two types of blow-holes can be attributed to damp sand or imperfect molding.

The oblong type of blow-hole, frequently found near the surface of castings can be traced to the presence of oxides in the steel, particularly to that of manganese oxide. In the preliminary deoxidation of steel, ferro-silicon and ferro-manganese are used. The products of these reactions, namely silica and manganese oxide, being of lower specific gravity than steel, will have a tendency to rise to the top of the ladle. However, some portion of these oxides will be entrapped in the steel. Unfortunately, silicon, in addition to combining with oxygen, also will be found, by microscopic examination, in combination with iron as iron silicates. Chemical analysis, however, will not disclose in what combination the manganese exists, that is, as carbide, sulphide or oxide. It is claimed that the last combination is the most deleterious of the three, for the reason that if a steel containing manganese oxide has been poured in a sand mold, there is a reaction between the oxide and the carbon of the steel when the steel has almost reached the point of solidification, resulting in the formation of carbon monoxide.

Oblong Blow-holes

The carbon monoxide, by expansion, will be forced near the surface of the castings, resulting in the formation of oblong blow-holes. When these blow-holes are formed, particularly in light castings, the base of the sink-head, or riser, already would have been chilled so that no further feeding therefrom is possible and the entrapped gas inevitably must remain in the finished casting. The physical qualities of the castings will be affected not only by unsoundness or blow-holes in the steel, but also by such impurities as slags and oxides, as well as by segregation and improper annealing or heat-treatment. It is claimed that steel which is segregated will not give uniform results in annealing or heat-treatment.

The addition of ferro carbon-titanium to steel for casting purposes is made immediately after the ferro-silicon addition when the steel is poured from the furnace and four to six pounds of titanium per ton of steel are used. In making the addition of titanium, care must be exercised that it be completed before the slag begins to flow, or the titanium will be acted upon by the slag and thus will be wasted. In open-hearth steel practice, six to eight minutes should elapse before the final addition of the last of the titanium and the pouring of the steel into the first mold.

Converter Steel Practice

In converter steel practice, where the finer sizes of titanium are used, this time may be reduced to three or four minutes. The holding of the steel in the ladle is essential, so that sufficient time may elapse for the slags and oxides, always present in molten steel, to rise to the surface. It is claimed that the combination of these slags with titanium oxide renders them more fusible and possibly, by increasing their volume, reduces their specific gravity. This lapse of time will not cause the metal to chill in the ladle because the oxidation of titanium is an exothermic or heat-producing reaction. Immediately upon its addition, the titanium will react on the oxides of iron and manganese, according to the following equations:

$$2FeO + Ti = TFe + TiO_2$$
$$2MnO + Ti = 2Mn + TiO_2$$

It will be noted, therefore, that titanium acts not only as a deoxidizer, but with the titanic oxide, formed by the oxidation of titanium, in addition, is a scavenger and cleanser. The use of aluminum as a deoxidizer must be discarded, because by its oxidation alumina, an oxide absolutely infusible at the temperature of molten steel, is produced.

By the use of titanium, steel will be made that will set quietly in the mold and which will have the following composition for soft, medium and hard castings:

	Carbon, Per Cent.	Silicon, Per Cent.	Sulphur, Per Cent.	Phosphorus, Per Ceut.	Manganese, Per Cent.
Soft	0.17 to 0.20	0.30 to 0.35	0.015 to 0.05	0.02 to 0.04	0.50 to 0.75
Medium	0.20 to 0.30	0.30 to 0.35	0.015 to 0.05	0.02 to 0.04	0.50 to 0.75
Hard	0.30 to 0.40	0.30 to 0.35	0.015 to 0.05	0.02 to 0.04	0.75 to 1.00

In the manufacture of electric steel for casting purposes it is pointed out that to obtain thorough deoxidation of the steel, the slag formed on the surface of the metal, under the high temperature of the arc by carburizing a good basic slag with coke, must remain in contact with the bath sufficiently long to accomplish the purpose. The presence of silica, fallen from the roof of the furnace, or impurities in the lime, might prevent the formation of carbide of calcium, in which case the slag would not completely deoxidize the steel. Assuming that the steel has been thoroughly deoxidized in the furnace, it will be reoxidized to a certain extent during the tapping into the ladle and will become contaminated with slag, as the latter usually flows into the ladle before the steel in this process. In case the arc of the electric furnace is acid instead of

basic, the process becomes simply a melting operation and the deoxidation must be effected as in the case of open-hearth steel.

In much of the electric steel that is now made aluminum is added in the ladle to overcome the reoxidation where a basic lining is used, or to deoxidize the steel in the case of an acid-lined furnace. It is pointed out that the use of aluminum is just as objectionable in electric steel as in any other, because of the formation of its infusible oxide, alumina, some of which segregates and remains in the steel to the great detriment of the latter. Complete deoxidation, however, can be effected by the addition of from four to six pounds of ferro carbon-titanium during the tapping of the steel into the ladle, in the case of a basic-lined furnace and it will take care of any reoxidation during the tapping. In the case of an acid-lined furnace, it will complete the deoxidation of the steel and also in both cases, by the fluxing action of titanic oxide, it will free the metal from slag and oxide inclusions. In this case, as in others, the steel should be held in the ladle from six to eight minutes to permit the slags and oxides, rendered more fusible by combination with titanium oxide, to rise to the surface.

Peining Cast Iron

By W. J. Keep

Question:—Will you kindly let us know how to pein cast iron? We manufacture cast iron tanks which show signs of leakage in the oil test. Will peining permanently overcome this defect?

Answer:—The success of this practice depends upon how porous the iron is in the casting. Peining breaks the grain, but generally stops the leak. Fill the casting with a solution of water and salammoniac and force this solution through the soft spot by pressure and let the casting stand several days to rust. It probably is more advisable, however, to correct the molding and casting methods and the amount of metal at this spot might be reduced in order that it will cool as rapidly as every other part of the casting. A chill also might be used to advantage.

An Acid-Proof Mixture

Question:—Will you kindly give me a formula for an acid and alkali-proof iron mixture?

Answer:—In a paper presented before the American Foundrymen's Association several years ago, the following mixture was given for this purpose: Silicon, 1 to 2 per cent; phosphorus, under 0.05 per cent; sulphur under 0.04 per cent, and manganese, 1 to 1.50 per cent.

The Crucible Situation

Crucible manufacturers are experiencing unusual difficulties in obtaining raw materials and as a result, the price of their product has been rapidly advanced. Shortly after the beginning of the European war an embargo was placed upon Ceylon plumbago which left the American supply in a depleted condition and even since the embargo has been lifted the shipments from Ceylon are far below normal. Plumbago, which enters so largely into crucible manufacture, has been practically doubled in price and the quality is inferior to that received prior to the war. The German clay used in crucible manufacture no longer can be obtained. The deposits are located in Bavaria, Germany, and no shipments have been made since early in 1915. Some makers of crucibles had large supplies of this clay on hand when hostilities started, but others have been compelled to substitute clays obtained in various parts of the United States and in some instances this has been mixed with the German clay.

Crucible makers have conducted many tests and experiments during the past 12 months to obtain a binding material to replace German clay and the difficulties thus experienced, in a measure, may be appreciated by the length of time required to prepare a graphite crucible for service in the foundry. From six to 10 weeks elapse from the making of the crucible to its delivery to the user. Then follow the practical tests in foundry operations. Fortunately, however, crucibles made with American clays as a binder have established unusual heat records. In one instance a No. 300 crucible had a run of 40 heats on manganese bronze and numerous reports have been received of 38 and 40 heats from No. 100 pots melting car box metal. It has been found, however, that there is a wide variation in the life of crucibles made by the same potter from the same materials and burnt in the same kiln. One melter will secure a large run from some of these pots while another reports a comparatively short life. It is certain, however, that as soon as crucible manufacturers generally become more familiar with the mixing and blending of American clays they will be able to produce crucibles equal to or superior to those manufactured with German clay as a binder.

However, greater care must be exercised in handling American clay crucibles. It is necessary to thoroughly dry and warm these crucibles before placing them in the fire and on the initial heat they should be warmed very slowly. Some users build a charcoal fire in the crucible before charging the metal and others place hot ashes in the crucible to heat it when it is placed in the fire for the first heat. It has been found that certain advantages are to be derived by heating the crucible first from the inside rather than from the outside. Care must be exercised to prevent wedging the crucible too tightly, as American clays have not the same tensile strength when hot as German clay. In a large measure, the advance in the price of crucibles can be attributed to the shortage of Ceylon plumbago and its unusually high cost, which today is more than double that which prevailed prior to the European war.

Loss of Sulphur in a Side-Blow Converter

Question:—What causes the loss of sulphur in the metal in side-blow converter practice? If the iron poured into the vessel contains 0.06 per cent sulphur, why should not the finished steel contain as much sulphur or more? A series of tests which we have conducted shows that there is a loss of sulphur in blowing.

Answer:—The loss of sulphur in the metal in side-blow converter practice appears to be due to oxidation and is favored by the presence of rather large quantities of manganese in the metal. This action occurs during the early stages of the blow when the iron and manganese are burning. In the usual run of cast iron for converter practice, sulphur occurs almost wholly as manganese sulphide. When manganese begins to burn, manganese sulphide is decomposed and the elements, manganese and sulphur, are oxidized, the manganese oxide passing into the slag and the sulphuric oxide escaping with the gases. This action occurs only at the lower temperatures, when iron and manganese start to burn. As the temperature of both increases, oxygen favors the more difficultly burning silicon. Tests made in our plant indicate that in normal converter practice the loss of sulphur is approximately equal to the total losses during the whole operation. If manganese is added to the bath at the time when the silicon starts to burn, the sulphur loss is increased. The increase in the loss of sulphur is independent of the amount of manganese added, all other conditions being considered, and appears to be due to holding down combustion temperatures within a range which favors sulphur loss.

Payment will be made for all contributions on foundry and pattern shop practice suitable for publication

Note—This sheet may be cut into two sections, 5 x 7 inches, and may be readily bound in note-book form.

WEIGHTS OF SOLID OCTAGONAL IRON CASTINGS

By R. R. McGowan

Example.—To find the weight of an octagonal iron casting 17 inches long, and 20 inches across the flats (size A on sketch). From table on Data Sheet No. 205, 1 inch of solid octagon 20 inches across the flats weighs 86.1536 lbs. Therefore weight of casting is 86.1536 lbs. × 17 = 1464.6112 lbs.

Distance across flats, inches.	Lbs. per 1 inch length.	Distance across flats, inches.	Lbs. per 1 inch length.	Distance across flats, inches.	Lbs. per 1 inch length.
1/8	0.0033654	... 5¼	5.9365215	17½	65.96135
... ¼	0.0134615	5⅜ ...	6.222594	 18	69.784416
⅜ ...	0.0302884	... 5½	6.515366	18½	73.715174
... ½	0.053846	5⅝ ...	6.81488	 19	77.753624
⅝ ...	0.08414	... 5¾	7.1211335	19½	81.899766
... ¾	0.1211535	5⅞ ...	7.4341134	 20	86.1536
⅞ ...	0.1649034	... 6	7.753824	20½	90.515126
... 1	0.215384	6¼ ...	8.41344	 21	94.984344
1⅛ ...	0.2725954	... 6½	9.099974	21½	99.561504
... 1¼	0.33654	6¾ ...	9.8184335	 22	104.245856
1⅜ ...	0.4072104	... 7	10.553816	22½	109.03815
... 1½	0.484614	7¼ ...	11.3211215	 23	113.938136
1⅝ ...	0.5687484	... 7½	12.11535	23½	118.945814
... 1¾	0.6596135	7¾ ...	12.9365015	 24	124.061184
1⅞ ...	0.75721	... 8	13.784576	24½	129.284246
... 2	0.861536	8¼ ...	14.6595735	 25	134.615
2⅛ ...	0.9725934	... 8½	15.561494	26	145.599584
... 2¼	1.0903815	8¾ ...	16.49034	 27	157.014936
2⅜ ...	1.2149004	... 9	17.446104	28	168.861056
... 2½	1.34615	9¼ ...	18.4287935	 29	181.137944
2⅝ ...	1.4841304	... 9½	19.438406	30	193.8456
... 2¾	1.6288415	9¾	20.4749415	 31	206.984024
2⅞ ...	1.7802434	 10	21.5384	32	220.553216
... 3	1.938456	10¼	22.6287815	 33	234.553176
3⅛ ...	2.10336	.... 10½	23.746086	34	248.983904
... 3¼	2.2749935	10¾	24.890376	 35	263.8454
3⅜ ...	2.4546084	 11	26.061464	36	279.137664
... 3½	2.638454	11¼	27.25954	 37	294.860696
3⅝ ...	2.8302804	.... 11½	28.484534	38	311.014496
... 3¾	3.02884	11¾	29.7364535	 39	327.599064
3⅞ ...	3.2341254	 12	31.015296	40	344.6144
... 4	3.446144	12½	33.65375	 41	362.060504
4⅛ ...	3.6648934	 13	36.399896	42 ..	379.937376
... 4¼	3.8903735	13½	39.253734	 43	398.245016
4⅜ ...	4.12259	 14	42.215264	44 ..	416.983424
... 4½	4.361526	14½	45.284486	 45	436.1526
4⅝ ...	4.6071984	 15	48.4614	46 ..	455.752544
... 4¾	4.8596015	15½	51.746006	 47	475.783256
4⅞ ...	5.1187354	 16	55.138304	48	496.244736
... 5	5.3846	16½	58.638294	 49	517.136984
5⅛ ...	5.6571954	 17	62.245976	50 ..	538.46

(Continued on Data Sheet No. 206.)

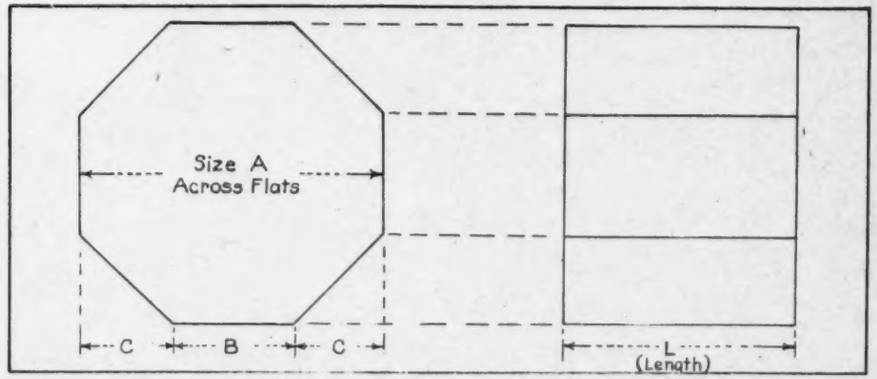
WEIGHTS OF SOLID OCTAGONAL IRON CASTINGS

By R. R. McGowan

(Continued from Data Sheet No. 205.)

If the weights for cast iron, given on Data Sheet No. 205, be multiplied by

1.08 it will give the weight of a similar casting in wrought iron or steel.
1.154 it will give the weight of a similar casting in brass.
1.54 it will give the weight of a similar casting in lead.
0.36 it will give the weight of a similar casting in aluminum.



HANDY FORMULAE RELATING TO OCTAGONS.

Given.	Required.	Formulae.
A	B	$A \times 0.4142$
A	C	$\frac{(A \times 0.4142)^2}{2}$
B	A	$\frac{B}{0.4142}$
B	C	$\frac{B^2}{2}$
C	A	$\frac{\sqrt{2C}}{0.4142}$
C	B	$\sqrt{2C}$
A	Area of End	$A^2 \times 0.8284$
A and L	Weight in lbs.	$A^2 \times 0.8284 \times L \times$ weight of a cubic inch of the material

Terraced Clays and Sands in the Hudson Valley. The Molding Sand Layer is Found on Top of the Benches 150 Feet or More Above the River

Mining Albany Molding Sand

By D H Newland

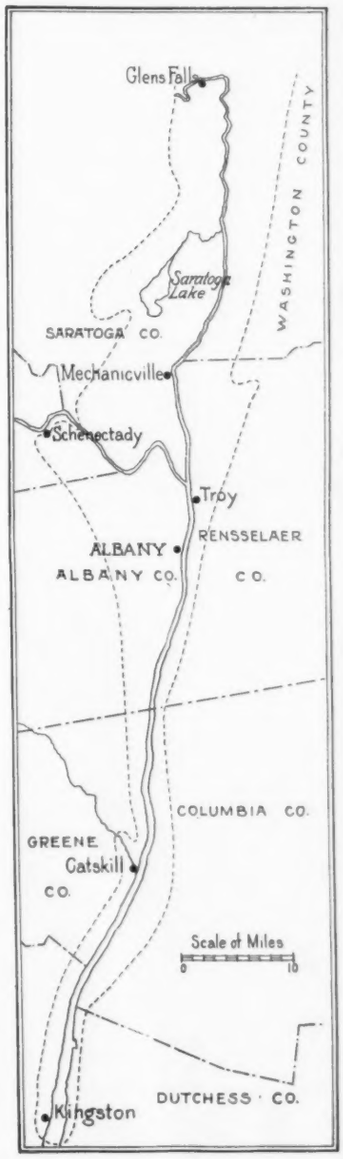
THIS paper deals more particularly with the features of molding sand as exhibited in the field. Its scope will be restricted to the description of the deposits in the Albany district, one of the better known sources of sands for general foundry use in the east and in some respects, perhaps, typical as an illustration of their occurrence.

Albany molding sand is the product of a single district, but has a more extended distribution than the name might suggest to one unfamiliar with the conditions. The district includes a stretch of about 100 miles on the meridian and takes in both banks of the Hudson river from near Glens Falls on the north to Kingston on the south. Albany lies near the center of the area, but by itself is not a very important factor in the industry, although good sand is found within the city limits.

Occurrence of the Deposits

The deposits occur here and there over the distance mentioned, but usually are restricted to a very narrow section within close proximity to the river. From Kingston to Albany county they do not reach back usually more than a mile or two from either bank. With the expansion of the valley near Albany through the entrance of the Mohawk, which occupies a broad valley that extends westward for over 100 miles, the sands attain a much wider development and are traceable on the west bank as far as Schenectady. North of the Mohawk the district again narrows perceptibly, but for a considerable interval it is still broader than the average of the southern section.

From an address delivered at the Atlantic City meeting of the American Foundrymen's Association.



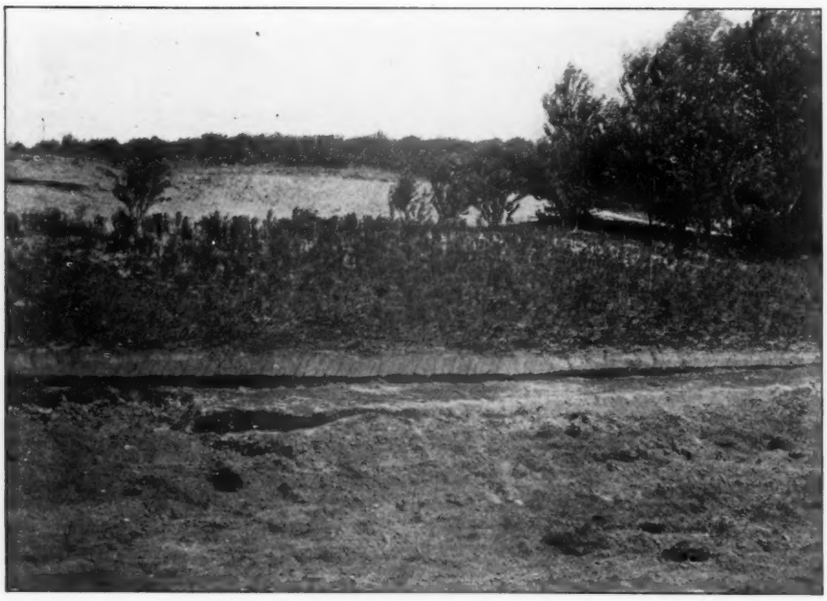
MAP OF THE ALBANY MOLDING SAND DISTRICT

In its limits as thus indicated the district conforms with certain geological conditions which need to be set forth before the discussion of the sand deposits themselves is taken up.

The present Hudson valley is an open, well-rounded excavation in shales and sandstones that belong to the so-called Hudson river formation of Ordovician age. These rocks seldom come to the surface within the lower ground, as they are mantled by unconsolidated sediments—clays, sands and gravels—which evidently were deposited ages ago, but still rather recently as geological time is reckoned. The latter beds attract the notice of visitors to the region owing to their being arranged in terraces, which rise abruptly from near the river to summits that for long distances are quite flat and preserve a uniform height. The terraces attain their greatest elevation in the north and also on the west edge of the district near Schenectady where their upper surface is about 400 feet above sea level. The general level of those in the middle and southern section is approximately 180 to 200 feet, but there are still lower ones in the south.

Formation of the Deposit

The sands and clays were laid down in standing water and their deposition dates back to late Pleistocene time when the Hudson, instead of flowing freely to the sea as now, was held back or impounded so that its waters reached the higher levels marked by the terraces. The sediment, swept into this temporary lake by the Mohawk and other tributaries, was deposited layer upon layer until the accumulations reached an altitude of 400 feet or more above the old river bottom and extended from side



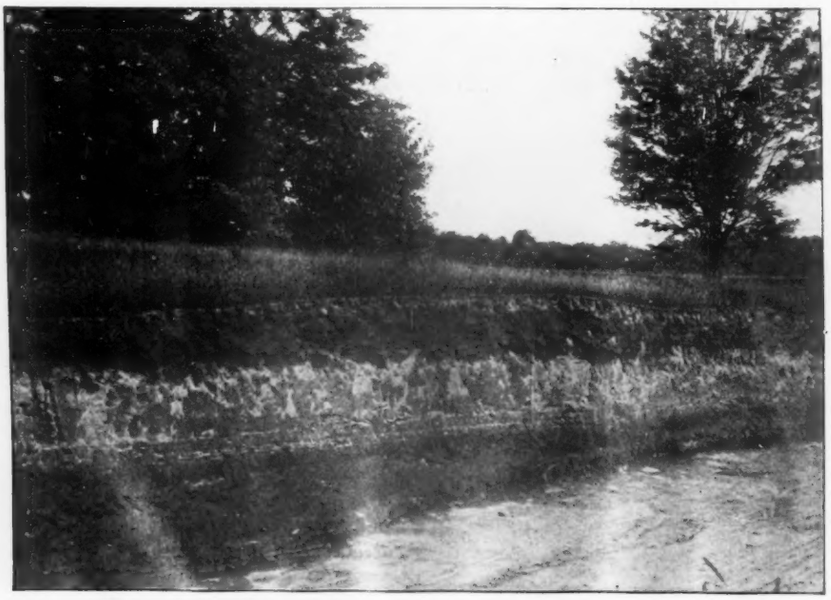
MOLDING SAND LAYER IN THE BACKGROUND WITH DUNE OF OPEN SAND ABOVE

to side of the valley depression. With the later lowering of the outlet the waters were drained off and the river began cutting down another channel through the soft beds which it now occupies.

The clays and sands retain their original stratified arrangement for the most part; the former especially show a division into horizontal layers or seams just as they were first deposited.

The clays occur mostly in the lower and the sands in the upper part of the series. The latter were laid down in the closing stages of the history of Lake Albany, as the flooded valley is called, and originally formed a mantle over the whole district. It is these surface sands that are of present interest.

At the present time the sand deposits are by no means continuous over the whole district. Lying at the surface they have been subjected to erosional influences which over some areas have effected their complete removal. In general, they are not very thick, 15 or 20 feet being about the maximum, except where they have been heaped up in ridges and dunes by the work of the winds. The action of the wind has a prominent part in the present arrangement and distribution of the sands, and they are still being shifted about wherever they are not anchored by a mantle of soil and vegetation. The area covered by the old Mohawk delta contains tracts occupied by live dunes that are in course of continuous change as to form and position. Frequently, the topography bears evidences of similar wind work, although the surface may have been protected from it for a long time by the growth of vegetation.



NORMAL OCCURRENCE OF MOLDING SAND. THE SUCCESSION FROM THE TOP TO THE BOTTOM OF THE BANK IS SOIL, MOLDING SAND, OPEN SAND AND CLAY

In consequence of this working over by the winds the sand now occupies no definite position in the series, but is distributed over the surface from near sea level to several hundred feet above. Its contact with the clays below may be seen in places to be quite irregular, although originally the sands were deposited on a level platform.

Another influence of the same agency is to be found in the evenness of texture which characterizes the sand; the first sorting by the water may have produced a fairly even grain, but no doubt this feature has been further promoted by the sifting action of the wind. The uniformity of texture does not obtain over long distances, but only within rather narrow limits, as the same layer may be seen to change gradually to a coarser or finer condition when traced along the surface. Some banks of a few acres extent may produce two or three commercial sizes. The coarsest grain seldom approaches that of fine gravel, the latter material being rarely met with among the molding sands.

The Drift Sand

The drift sand from the bare, wind-swept areas has the same textures as the sand that lies under sod, but differs from the latter markedly in appearance and in other features. It is an incoherent aggregate running readily on slopes under slight propulsion, and has no strength to speak of, when moistened. Its color is grayish from the admixture of dark grains of shale and sandstone with those of white or transparent quartz. On the other hand, the sand taken from under an old soil has a brownish yellow or ochreous color and contains enough clay usually to show good bonding power. Banks of the latter will stand vertical for a long time unless thoroughly dried-out by removal of the protecting cover. This yellow, loamy sand, in depth, usually grades over into a sand of a looser, more open nature, which resembles more or less the drift sand.

It is rather evident from the associations that these variations reflect different stages of weathering and decomposition after the sand was deposited. Wherever the sand has been held down by soil for a long period the shaly particles have disintegrated so as to form clay and at the same

time some of the iron has been released and oxidized. The change has proceeded from the surface downward under the influence of moisture, frost and probably the acids of the soil.

The molding sand represents a very small fraction of the whole accumulation of sand. Its occurrence is quite without rule, except that when present it is always the layer directly below the soil. In many places this layer may lack the necessary qualities of texture or cohesiveness to constitute a good sand, and there is no way of determining the conditions except by actual exploratory tests. The unsodded drift sand, as already stated, has little bonding power, although in texture it may resemble the commercial material.

The thickness of the molding sand layer ranges from a few inches up to 4 or 5 feet, which represents about the maximum for the thoroughly weathered layer. In the usual run of the bank the thickness probably is not much more than 18 or 20 inches. Its limits above and below are defined quite sharply, but less so in the latter direction where it changes rather quickly, that is within a few inches, into grayish, open sand. The sod cover with the soil usually amounts to 10 or 12 inches.

The continuity of the layer shows no interruption as a rule from minor irregularities of the surface; but the sand is cut off by stream depressions and never extends far down the sides of steep banks. The product comes mainly from the upland flats, 200 feet or more above the sea level.

Composition and Textures

The commercial molding sand consists almost wholly of quartz grains bonded by clay. Examination of numerous samples evidences its very simple mineral composition. Some unresolved shale or sandstone, an occasional particle of feldspar, chlorite or other silicate constitute about the only variations that may be noticed. The quartz particles when freed from the attached coating of clay are seen to be tinted a faint yellow by limonite which adheres to their surface and lends the ochreous color to the sand observed in the mass.

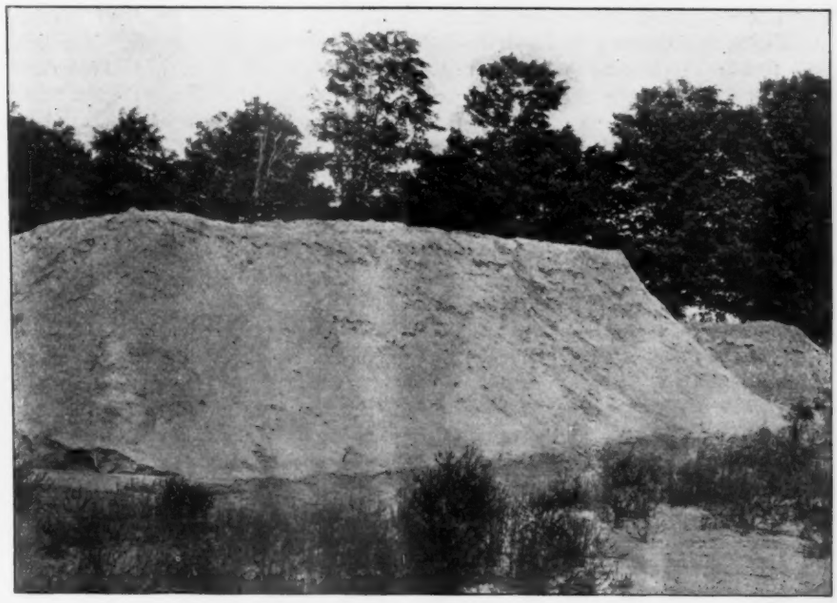
The ratio between granular aggregate and clay bond varies, of course, in the bank within rather wide limits. In the usual run of commercial sand of the finer sizes the latter amounts to about one-third or one-fourth by weight of the whole mass.

A feature of the sand that comes out prominently when viewed under the microscope is the angularity of the individual particles, even down to the very finest that can be seen. This is no doubt of practical significance, since it has been shown that angular particles do not pack so closely as round ones and, therefore, should have increased permeability to gases. The angularity is evidenced by wedge-shaped forms and concave bounding planes which are characteristic of quartz sands comminuted by crushing under pressure rather than by attrition or abrasion. Such sand is formed by glacial erosion.

METHOD OF STRIPPING THE SOD FOR REMOVAL OF THE MOLDING SAND. IN THIS ILLUSTRATION THE MOLDING SAND IS ABOUT 18 INCHES THICK

Although several different grades or sizes of sand are obtained, it is the finer sizes which constitute the more typical material commonly associated with the name Albany sand. The grading by the shippers, as will be explained later, is not based on uniformity of practice and does not always lead to closely similar results; but in general, the sands are graded from No. 0, the finest, to No. 4, which is the coarsest that is commonly shipped. Mechanical tests of No. 0 sand from different banks show that in the average from 94 to 98 per cent of the whole, inclusive of clay, will pass the 100-mesh screen, or in other words is finer than 0.147 mm (0.0058 inches). An average sample from a stock pile of this grade, to give an example, showed 96.64 per cent as passing the 100-mesh, while all but 0.71 per cent passed the 80-mesh sieve.

The methods employed in the production of the molding sand for the



MOLDING SAND IN STOCK PILE AWAITING SHIPMENT

market are simple and in view of the large quantity that is shipped from the district they may appear at first as somewhat crude. The conditions, however, are such that mechanical methods cannot well be adapted to the purpose. These conditions pertain particularly to the variable thickness of the layer as it is traced from place to place, ranging from a few inches to 2 or 3 feet and to the rather abrupt changes of texture which occur and which require that constant attention be given lest the grades become mixed.

The entire operation of removing the sod, and excavation of the sand is carried out with the hand shovel. The usual practice is to work the ground in sections, according to the number of grades that may be present in the land. The first work is to take off the sod, carefully cutting down to the lower limit of the soil, from a strip a few rods long and about 3 feet wide. The sod and soil after the first strip is worked are placed in the excavated ground, which practice is followed throughout so that at the end the land may be returned to agricultural use without material decrease of fertility. The bank of molding sand which is thus exposed is shoveled into wagons, care again being necessary not to extend the cut below the layer into the open sand. The sand is thus hauled to the nearest siding for shipment, or is placed in stock pile for loading in the future.

Grading the Sand

The business for the most part is in hands of regular dealers who carry on operations in several places and are able to supply the various requirements of the market. The individual land owner seldom has enough familiarity with the grading of sand to enable him to undertake the business. The right of digging the sand on a parcel is sold under contract, the shipper paying either a lump sum or on a tonnage basis with the agreement that he shall have a certain term of years in which to complete the removal. The amount that is paid depends altogether on circumstances which vary with each particular tract, such as the grade of the sand, thickness of the layer, and distance to railroad siding, if in the interior, or to the river if that be near. The crop obtainable is placed roundly at 1,000 tons for each 6 inches of thickness, a 30-inch layer thus yielding 5,000 tons to the acre.

Haulage is one of the largest items in the cost and one that cannot well be reduced; it is likely rather to increase as time goes on and the more accessible lands are exhausted. About 5 miles is the maximum limit of haulage at present.

The methods of production are the same as were employed in the beginning of the industry in the district, but it is doubtful if they can be materially improved as to mechanical features. The absolute need of personal contact with and supervision of the operations is a bar to any great change in that respect.

Lack of Standards For Grading

The weakest feature of the practice, in the writer's estimation, is the lack of positive standards for the grading of the sand in the field. As conducted at present, the grading is a matter of rule-of-thumb tests, dependent for their value upon the skill and experience of the practitioner and consequently involving an interminable personal factor. In such circumstances it could hardly be expected that uniformity of grading would obtain between different producers; on the other hand the way is opened for considerable variation not only as between different producers but also with regard to separate shipments from the same source.

Any plan for improvement of the practice would seem to have its basis in the introduction of physical tests in line with those employed in laboratory work, but not necessarily so refined or comprehensive as the latter. The Albany sand shows a degree of constancy in many features that makes for simplicity in the testing operations. They are all quartz sands of high purity, at least the weathered surface portion that is the source of practically the whole output, and the constituent grains are of similar physical development, differing only in size. The bond is also of similar nature throughout. Consequently, the features upon which the varied properties of the sands in use depend are first the relative grain sizes and second the clay percentages. A method for comparison of these features that is readily applicable in the field should not prove difficult to find, in fact may be said to be already at hand.

The present output is obtained from numerous localities that altogether are scattered pretty well over the whole district. By far the largest share, however, comes from the central section, that is within a stretch of 20 miles or so north and south of a line drawn between Schenectady and Albany. Among the more important localities for the shipment of the sands are Elnora, Round Lake and Mechanicsville, Saratoga county; Albany, Wemple, Selkirk and Delmar, Albany county; South Schenectady and Carmen, Schenectady county; Rensselaer and Van Hosen, Rensselaer county; Coxsackie, Green county; Rhinecliff and New Hamburg, Dutchess county; and Kingston, Ulster county.

The annual production ranges from 300,000 to 500,000 tons a year. The following statistics represent the aggregate production of molding sand in New York state for the years 1908-1914 as collected by the state geologist's office. They may be regarded as practically equivalent to the output of the Albany district, for the industry outside is very small:

Year.	Tons.
1908	312,819
1909	468,609
1910	471,351
1911	476,014
1912	469,138
1913	504,348
1914	310,727

A production of 500,000 tons a year means the exhaustion annually of about 125 acres of a 2-foot layer, based on an estimated yield of 1,000 tons for each 6 inches of sand on an acre, which is said to be about the rate of yield. On this basis a square mile of territory is worked over every five years.

Sand Supply Diminished

There is no doubt that the supply has been appreciably diminished by past operations which have been conducted on an extensive scale probably for the last 50 years or more. This is shown by the fact that the sand is now hauled from more distant points than formerly. Yet there is a large amount of unworked territory, sufficient probably to meet the demand for a long time to come, but at somewhat increased costs of production. The supply of the finest grade is likely to give out first, since it is not so plentiful as the others.

The production of artificial molding sands to compete with the finer grades of Albany sand does not appear feasible, so long as the latter can be obtained at moderate cost. To grind such tough material as quartz to a similar degree of fineness is expensive, and there are physical difficulties which may prove insurmountable, so far as practical operations are concerned. One of these is the close attachment or adhesion between the clay and the quartz, which no doubt is promoted by the slightly corroded or roughened surfaces of the grains and their film of iron oxide. Furthermore, it would probably be very difficult to obtain an even distribution of the bond comparable to that in the natural sand of which every particle is separately coated by clay.

The Electro-Deposition of Cobalt---I

By E P Later

WHILE the electro-plating industry has grown to large proportions, only six or eight metals are used commercially to any extent; considerations of cost, the difficulty of working out a suitable bath, or a real or supposed inferiority of the finish produced, have operated to keep the others from being employed. Within the last few years, however, considerable work has been done in thoroughly investigating the possibilities of employing other metals than those generally used. This is especially true of the metal cobalt which has been studied by several investigators; of these, Kalmus, Harper and Savell, working under the direction of the Canadian Bureau of Mines have carried out a most painstaking series of experiments and the conclusions which they have reached are so interesting to every plater that they are worthy of careful consideration.

Properties of Cobalt

For the sake of those who may not be familiar with cobalt, it may be stated that it is a white metal, similar to iron in appearance, possessing a specific gravity of 8.9 and a melting point of about 1,492 degrees Cent. It is harder than either iron or nickel, is malleable, very ductile and extremely tenacious; wire drawn from it is several times as strong as iron wire of the same size. It is magnetic, retaining its magnetism at a white heat, and like iron, is rather easily dissolved by dilute nitric acid and sulphuric and hydrochloric acids. Chemically, it is like iron and nickel in its properties and compounds. It buffs readily to a very brilliant white surface, with a bluish cast.

It is by no means a new metal, as it has been known for a great many years, but it is not particularly abundant nor widely distributed, the bulk of the cobalt of commerce coming from various localities in Canada. Recently, it has been employed to quite an extent in alloys and special steels.

Various attempts, extending over a considerable length of time, have been made to plate cobalt, but, although a number of writers have had something to say about it, heretofore there has been no general agreement among them on many essential points, so the available knowledge has been largely unsatisfactory or worthless.

The present investigation comprised both laboratory work and thorough prectical tests under commercial conditions in a large plating establishment and, therefore, should be unusually trustworthy. In the former, small glass tanks were used, with electrodes 2 x 3 inches and, in general, the conditions closely approximated those obtaining in commercial work; the data were recorded without corrections, although it is to be noted that if the work had been carried on in a larger tank the electromotive force required for any given current density would have been smaller, as a larger conducting field of electrolyte would thus be afforded. The scope of the work consisted in making frequent readings of the voltage, current and time, noting the changes in appearance of the solution and electrodes, determining the concentration of the bath and studying the physical characteristics of the deposited metal. In working out the current efficiency, the current readings were taken at intervals of two minutes and the weighing of the cathode before and after plating was carefully done.

Both rolled and cast anodes were used, the former made by rolling 1 inch square ingots down to ¼ inch thickness from which were cut anodes of the required size. The cast anodes were poured in sand molds and finished on an emery wheel.

It was ascertained that cast cobalt anodes, the same as nickel, went into solution much faster than the rolled and it is possible to use the two in such proportion that the bath will remain constant in composition, thus obviating any danger of becoming too alkaline by reason of the too rapid solution of the anode, or deficiency in metal, which is also objectionable. Cobalt anodes, however, at least in the baths employed, dissolve at an appreciably greater rate than nickel anodes in the usual nickel baths, which is a desirable feature from a practical standpoint, and there is the further advantage that they may be used of greater purity.

Rapid Plating Bath

It can be readily appreciated that the more soluble a metallic salt is in water, the more useful it will be to the plater, other things being equal. In this respect certain cobalt salts are superior to those of nickel, as it appears from some tests of their solubility that, while the single cobalt and nickel sulphates do not differ much, the cobalt ammonium sulphate is about two and one-half times as soluble as the corresponding nickel salt and should, therefore, give an extremely rapid plating bath, which has been found to be the case. The single cobalt sulphate does not lend itself so readily for plating purposes without the addition of other substances, which naturally tend to load a bath unduly, so the fact that it is not very much more soluble than the nickel salt is not a serious matter.

Probably some of the readers of THE FOUNDRY may desire to investigate the possibilities of cobalt plating, and to prevent useless duplication of work and to show which baths were not well suited for use, as well as those which gave satisfactory results, this part of the subject will be discussed in detail.

After preparing various compounds of cobalt in the laboratory, the investigators experimented with 16 different types of baths, containing different salts of this metal and employing several addition

agents. It is not possible to give all the data taken during the course of the work, but the general conclusions which can be drawn will be presented and should contain enough information for most purposes.

1—Cobalt-ammonium Sulphate Solutions

The first bath, which may be designated as *A*, was made up about one-third saturated, analogous to a nickel bath recommended by Langbein, and contained cobalt sulphate, 30.9 g., ammonium sulphate, 26.3 g. and water, 1 liter. It was found that this would give satisfactory deposits at current densities up to 0.80 amperes per square dm. (7.5 amperes per square foot) which is higher than for the corresponding nickel bath and, further, it did not change in metal or acid content even after long use.

A second bath containing cobalt-ammonium sulphate, 200 g., was made up and proved to give very good deposits up to 4 amperes per square dm (37 amperes per square foot) which is several times the highest allowable current density for any commercial nickel bath; this means, of course, but one thing, extremely rapid plating, with consequent reduction in time. This bath also remained constant in composition after extended use at the permissible current density. It is interesting to note, too, that the efficiency of this solution was very high; measurements showed that this amounted to 98 per cent at a current density of 1 ampere per square dm. (9.3 amperes per square foot) and about 90.5 per cent at 3 amperes per square dm. (27.9 amperes per square foot) which is as high as the best nickel bath used at much lower current densities.

It was found that the best results were obtained when the bath was run neutral; when slightly alkaline, the color of the deposit was grey and the latter showed blisters, with a tendency to peel and pit, while that from an acid solution was dark. Finally, it may be stated, that the freedom of this bath from boric acid, magnesium salts and other agents which are often used in nickel solutions is decidedly a point in its favor.

A third bath, midway in concentration between the two referred to, was found to be somewhat better than the first, but generally inferior to the second; it was neither so rapid nor satisfactory at high current densities as the latter.

On the whole, this type of bath proved to be one of the most satisfactory of all of those tried: the deposits were very brilliant, with a bluish cast, hard and fine and in every way equal to the best nickel plate.

2—Cobalt-ammonium Sulphate With an Excess of Ammonium Sulphate

The latter salt was added with the idea of increasing the conductivity, but this type did not give very satisfactory deposits, in all ways. For instance, 0.90 ampere per square dm. (8.5 amperes per square foot) seemed to be the upper limit of current density and unless the solution were boiled the plating at densities much below this was not good. When run at the proper current density, fine deposits were obtained on brass and steel and the conductivity was considerably higher than for the corresponding nickel bath, but the solution tended to become acid after a few hours, necessitating an adjustment. On the whole, it did not show up nearly as well as the one in the previous series.

3—Cobalt-ammonium Sulphate With an Excess of Ammonium Sulphate and the Addition of Citric Acid

This bath resembled in composition a nickel solution which formerly found considerable favor, but the results obtained from it were not satisfactory. The effect of adding sodium sulphite, was then tried making a bath, *B*, containing cobalt sulphate, 34.5 g.; ammonium sulphate, 50.3 g.; citric acid, 4.2 g. and sodium sulphite, 1.7 g. per liter. A third bath resembling the first and containing cobalt sulphate, 52.7 g.; ammonium sulphate, 31.5 g. and citric acid, 4.5 g. per liter and a fourth, much more concentrated, cobalt sulphate, 78.5 g.; ammonium sulphate, 129.7 g. and citric acid, 13.7 g., were also prepared and tested.

In general the deposit, within the limit of the allowable current density, from this type of bath was satisfactory and buffed well. The first three solutions were not suitable for extremely rapid plating, although the second gave good deposits at 1 ampere per square dm. (9.3 amperes per square foot) while the allowable current density for the other two was somewhat lower. The fourth, which was more concentrated, worked well up the limit of 1.5 amperes per square dm. (13.9 amperes per square foot) and the efficiency was very high, but the bath showed a decided tendency to become alkaline and higher in metal content, when used with cast anodes, and therefore might not be entirely suitable for commercial use.

For purposes of comparison, a nickel solution of analogous composition was made up and tested. Among other things, it developed that the voltage across the electrodes of this tank was over twice as great as for the cobalt bath, using the same electrode distance, area and current density, showing again the greater conductivity of the latter solution.

4—Cobalt-ammonium Sulphate With Ammonium Chloride

The first bath had the composition, cobalt sulphate, 23.5 g.; ammonium sulphate, 20 g. and ammonium chloride, 30 g. per liter; the second differed somewhat in containing slightly less ammonium chloride, but 9.5 g. boric acid. The experiments showed that the first bath gave good deposits on brass and iron up to a current density of 1.5 amperes per square dm. (13.9 amperes per square foot); the other required a somewhat lower density, so, while fairly rapid, they are less so than some of the baths previously considered. The boric acid seemed to have a whitening effect on the deposit, while the neutrality of the baths did not change and the efficiency was high, over 92 per cent.

5—Cobalt Chloride With Ammonium Chloride

A bath containing cobalt chloride, 54.8 g. and ammonium chloride, 54.8 g. per liter was prepared, as the analogue of a nickel bath which has been used for plating on zinc, also for producing dark deposits. As might be expected, the cobalt deposit was dark and might be satisfactory for some classes of work, but the speed of plating did not compare with that of some of the other baths. Zinc could be plated in a satisfactory manner if there was enough agitation to remove bubbles from the cathode.

6—Cobalt-ammonium Sulphate With Boric Acid

The first bath prepared did not give satisfactory results, but a second containing more metal, cobalt sulphate 38.6 g.; ammonium sulphate, 32.9 g. and boric acid, 38.8 g. per liter operated to better advantage up to current densities of 1 ampere per square dm. (9.3 amperes per square foot).

7—Cobalt-ammonium Sulphate, Cobalt Carbonate and Boric Acid

A good deposit could be obtained from this bath only at rather low densities and the addition of a small amount of sodium sulphate did not improve the bath very much. Further, cast anodes were attacked very rapidly and the bath became alkaline; as a general thing, cobalt baths which have been improved by adding this agent do not remain constant enough in composition for most commercial work.

8—Cobalt Sulphate, Potassium Citrate and Ammonium Chloride

Two baths were prepared, the second being considerably more concentrated than the first and containing, cobalt sulphate, 40.5 g.; ammonium chloride, 17.6 g. and potassium citrate, 17.6 g. Both gave good deposits, but were not suited for very rapid plating as the highest current density allowable with the second was 1.25 amperes per square dm. (11.6 amperes per square foot) while the other was lower. It was found that the one for which the formula is given could be

used for plating on zinc at current densities up to 0.5 amperes per square dm. (4.6 amperes per square foot).

9—Cobalt Phosphate and Sodium Pyrophosphate

This bath, analogous to a dark-plating nickel solution for decorative work, proved to be more satisfactory than the latter; the voltage required was very much higher than for other cobalt baths.

10—Cobalt-ammonium Sulphate and Magnesium Sulphate

Good deposits were obtained with this type of bath with current densities up to 0.75 ampere per square dm. (6.9 amperes per square foot).

11—Cobalt Sulphate, Ammonium Tartrate and Tannic Acid

This bath did not prove very satisfactory.

12—Cobalt Sulphate, Potassium Tartrate and Tartaric Acid

While similar to the preceding, this bath proved to be an extremely fast plater, compared to nickel solutions, since it withstood being operated at current densities up to 11 amperes per square dm. (102 amperes per square foot).

13—Cobalt Sulphate, Sodium Chloride and Boric Acid

Two baths were made up on this general formula and while the first did not work well at all current densities tried, the second, containing, cobalt sulphate, 312.5 g.; sodium chloride, 19.6 g. and boric acid, nearly to saturation, permitted working at densities as high as 26.4 amperes per square dm. (245 amperes per square foot) and the limit had not yet been reached. It throwed well and the efficiency was almost 100 per cent. By reason of the extremely high current density employed the plating time with this bath could be cut to a very small fraction of its usual length. In three minutes a deposit was produced which withstood buffing and testing as well as a nickel coating plated for one hour, and in general appearance it was equally satisfactory. This bath also proved to be satisfactory for producing heavy deposits, which often give trouble, but at current densities above 56 amperes per square foot there was some treeing on the cathode. Incidentally, it required little or no ageing, good work being turned out practically at once.

14—Cobalt Sulphate, Ammonium Sulphate, Magnesium Sulphate and Boric Acid

A bath of this type gave satisfactory deposits at all current densities up to 3 amperes per square dm. (28 amperes per square foot), with a current efficiency of about 96 per cent.

15—Cobalt-ethyl Sulphate, Sodium Sulphate and Ammonium Chloride

A patent has been taken out on a nickel bath of this type, used for the production of heavy and dense deposits; the cobalt solution gave satisfactory results, as far as the coating was concerned, but the allowable current density was low, less than 3 amperes per square foot.

16—Cobalt Sulphate, Ammonium Sulphate, Ammonium Chloride and Boric Acid

Satisfactory deposits were obtained from this type of bath with both nickel and cobalt, but the allowable current density was low, about 9 amperes per square foot, and an attempt to increase the metal content resulted in crystallization.

The results of this experimental work were so interesting and opened up such possibilities that arrangements were made to try two of the most promising solutions on a commercial scale, under strictly commercial conditions and limitations, in the plating room of an automobile concern.

The first bath tried out was *B* of the first series, and it was subjected to a very thorough and searching trial on all of the points which are of interest to the plater to determine whether the solution is a good, commercial proposition. Without going into the details of the report which was issued at the completion of the test on this and the other bath, it may be said that the results were eminently satisfactory. Using the *13B* bath, automobile parts, which ordinarily required to be plated one hour in a nickel solution, were given a good finish in 10 to 20 minutes in the cobalt bath and subsequently were buffed severely without any sign of defect. Perhaps the severest test of the coating, however, was plating 1-inch steel tubes for two hours at a current density of 28 amperes per square foot and then drawing them down to 5/8-inch, without injuring the deposit.

Remarkable Work

The work with the *13B* bath seems to be even more remarkable. Deposits were produced at a variety of current densities, some very high, but in all cases they buffed with perfect ease and gave a beautiful finish. The statement is made that a three-minute deposit of cobalt resisted corrosion as well as a one-hour deposit of nickel, perhaps by reason of the greater hardness and density of the former, and at once the possibility of finishing cutlery and skates presented itself. Some of these parts were plated with cobalt and the results seem to have been all that could be desired.

It seems, therefore, that an important addition has been made to our knowledge of plating with cobalt and that a new and effective instrument has been placed in the hands of the plater. Many concerns are said to be investigating this subject, but up to the time this was written little or nothing had been published. There is no doubt, however, that it is well worth looking into, for although cobalt is more expensive than nickel, the great speed of plating and the fact that thinner deposits may be used tends to offset this. It may be added, also, that the use of such high current densities as given, is not entirely new, as several of the common metals have been plated at extremely high densities, although it is not the usual practice to do so.

For convenience in preparing small baths for experimental work the formulas of the baths described have been given as the number of grams of salt in one liter of water; to convert these into ounces per gallon, multiply by 0.133.

Red Varnish

We are experiencing considerable difficulty in mixing a serviceable red color varnish and we would appreciate a recipe for this work.

To mix a serviceable red color varnish the best materials obtainable must be used. Procure good colors ground in varnish and good extra rim varnish. If baking is necessary, use baking varnish. To mix, take one pound of the color and thin with just sufficient turpentine to form a paste, then add the thinned color to one pint of varnish. If this mixture has too much body, add more varnish until proper transparency is obtained; one pound of color to one quart of varnish is usually satisfactory. This gives a good, hard coating with a fine gloss. As the durability of the varnish depends to a large extent upon the condition under which it is applied, we would suggest that this point be given special attention.

Varnish must not be chilled during preparation or while drying. Cold drafts will ruin the best varnish after its application. Never mix two brands of varnish or add anything other than pure colors and turpentine. Apply the varnish in a moderately warm room, kept at uniform temperature. Frequently the paint or coating beneath the varnish is responsible for very inferior service. Moisture in the article or the paint covering will shorten the life of any varnish.

Safety Kinks for Cupolas

By Jas. S. Eagan

In the November, 1915, issue of THE FOUNDRY was published an article, entitled "How to Increase Safety of Cupola Operations." For some time we have been using kinks that accomplish the purpose of two of those described in that article, and, as we believe our methods are preferable to those described, we believe that they will prove of value to foundrymen generally.

In Fig. 2 of the article referred to, it is to be assumed that in dropping the bottom doors of the cupola, the support under the doors is removed by the old method of knocking this support away with a long-handled hook. Fig. 1, accompanying this article, shows a way of dumping the refuse that is much safer than this old ***hit and run*** method. As will be noted in this illustration, the support *A* under the cupola doors is set on the floor with its lower end encircled by a link *B*. One end of a cable is attached to the eye of the hook *C*, the cable passing through a block fastened to the floor, while the other end is attached to an elevator. When the elevator is raised, the first effect of the pull on the hook is to draw the support from beneath the cupola doors, dropping the cinders and slag. By this method of dropping bottom it is unnecessary for any one to be in the vicinity of the cupola and the danger of burns is eliminated. After the support is pulled from under the doors, the hook continues to move along slowly, giving time for all the contents of the cupola to drop down, and after it has traveled 12 or 14 inches, it picks up the breaker *D*, which breaks up and drags the refuse from under the furnace.

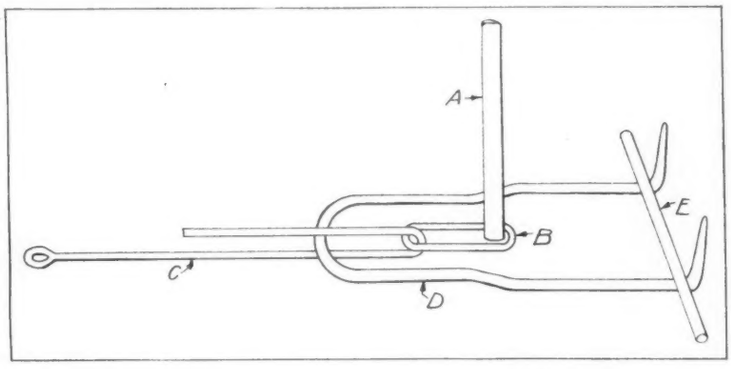


FIG. 1—SAFETY KINK FOR DROPPING CUPOLA BOTTOM

The rake shown in Fig. 2 of the article referred to, has a tendency to drag out the drop in a compact mass, and, when the cinders and slag are in this condition, it is practically impossible to quench the mass so that any unburned coke will not be consumed during the night; furthermore, when the drop cools in one solid lump, it is difficult to break it up and handle it the next morning. On the other hand, the breaker, shown in Fig. 1, with its two upturned points, breaks up the refuse and strings it out in a comparatively thin layer so that the drop can be quenched thoroughly, and any unburned coke can be saved. The following morning the refuse can be removed easily; *E* is a rod which is laid on the breaker to aid in drawing out the drop.

Fig. 2 shows a cupola screen which has the advantage of simplicity over the one described in the article, as all that is required to adjust the device is to insert it cornerwise through the door into the cupola. The arms *A* bear against the outside of the cupola above the door. A bolt, the head of which is shown at *B*, drops inside the lining of the cupola, and the screen is thus held securely horizontal. This device, we believe, is as effective as the one illustrated in the article, for the danger of the chipper is from brick and slag falling from above the level of the cupola door, and not from below the door, as the lining of the cupola below the door is glazed-over by the intense heat and holds firmly. When there is a strong draft up the cupola, as it frequently the case on cold days, a layer of cloths on the screen effectively stops the current of air, preventing the waste of heat, and protecting the chipper from working in a draft. This, of course, darkens the lower part of the cupola, and therefore, an electric light extension cord is passed through the screen, and the light is hung inside the furnace.

A four-page folder has been issued by the Joseph Dixon Crucible Co., Jersey City, N. J., describing a crucible clay and graphite mixture. In brass foundries it is adapted for patching cracked or worn furnace linings, patching and lining bull ladles, etc. In iron foundries it is serviceable for lining ladles and cupolas.

Melting in a Small Cupola

By W. J. Keep

Question:—We are experiencing considerable difficulty in the operation of our cupola, the tuyeres becoming clogged and the iron freezing. The air pressure seems to be sufficiently low, while the tuyere area is of ample size and a sufficient volume of air gets to the iron. Our charges average about 200 pounds each. We find it practically impossible to run off the slag and the tuyeres clog and the iron freezes when we try to melt over 2,600 pounds. However, we are anxious to increase this output to two tons per heat. The cupola is 20 inches inside diameter, the front tuyeres are 9 inches from the bottom, the blast pressure (fan) 3½ ounces, charging door 6 feet above the tuyeres and the tuyeres are 1½ inches above the slag hole. The bed charge consists of 210 pounds of coke, 136 pounds of pig and 264 pounds of sprues and stove scrap, while the subsquent charges consist of 26 pounds of coke, 136 pounds of pig and 264 pounds of sprues and scrap. Each charge contains ten pounds of limestone. The iron comes quite hot except the last 100 to 150 pounds.

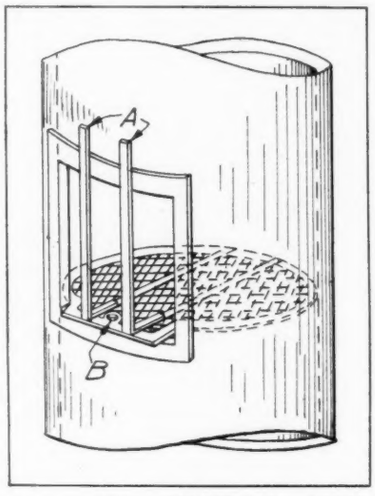
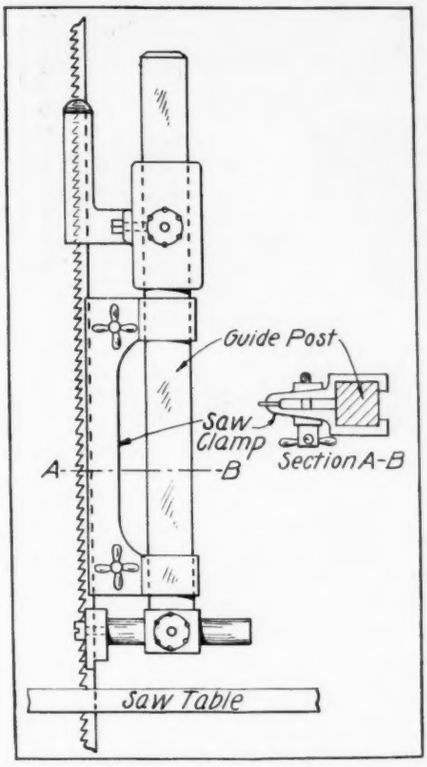


FIG. 2—SAFETY SCREEN FOR CUPOLA

Answer:—You are expecting too much from a small cupola and are now exceeding its capacity. I am running a cupola 21 inches inside of the lining with a 6-ounce blast. The tuyeres are 10 inches above sand bottom. The top of the slag hole is 2 inches below the bottom of the tuyeres. There are six tuyeres, 4 inches square and the slag hole is midway between the back tuyeres so that the blast will not chill the slag. Slag runs after the third charge is down. A double handful of limestone is used on each charge. The bed coke extends 15 inches above the tops of the tuyeres. The iron charges are 200 pounds and the coke 26 pounds. The capacity of this cupola is 3,000 pounds in 15 charges, but

by exercising care we run 20 charges, or two tons and are doing so today. We break pig iron as small as we can, the tough irons into 9-inch lengths, and those easily broken into 6-inch lengths. Scrap



A HANDY BAND SAW FILING CLAMP

is broken as small as the pigs and charging is carefully done. This cupola is made in 18-inch sections, which enables us to reach into each section to repair the lining. The cupola is lined with brick lying flatwise end up giving a little more than a 3-inch lining. The lining burns to about 22 inches inside before we put in a new lining. Your cupola has 10 per cent less capacity than our furnace, yet your output is greater. You do not give the size of your shell. Perhaps you can line it to 28 inches inside, which is as small as a stationary shell should be made. Locate the tuyeres 12 inches above the sand bottom and make each of the six, 3 inches high x 8 inches broad at the inside of the lining. You would then charge 300 pounds of iron to 30 pounds of coke and could melt six tons or more. We have such a cupola. Alter your slag hole, reduce the size of your charges which are now 300 pounds instead of 200, leave your wind as it is and when you get the slag to run, your last iron will be hot.

The headquarters of the Stupakoff Laboratories will be located at 6364 Frankstown avenue, Pittsburgh, during the erection of its new laboratories on Hamilton avenue, and all communications should be sent to this address.

Band Saw Filing Clamp

By M. E. Duggan

In the accompanying illustration is shown a band saw filing clamp which we have designed and which enables us to file a saw in considerably less time than by clamping in a vise. This clamp consists of a pair of jaws made of iron or hard maple, the jaws being recessed, as shown in the sectional view, to fit over the guide post. The jaws, by slightly turning the clamp screws, grip the post and clamp the saw. The tension on the saw always is uniform and as soon as the teeth move in a vertical line the saw always is brought into correct position for clamping. Releasing the jaws, shifting the saw and reclamping require no effort and can be accomplished almost instantly.

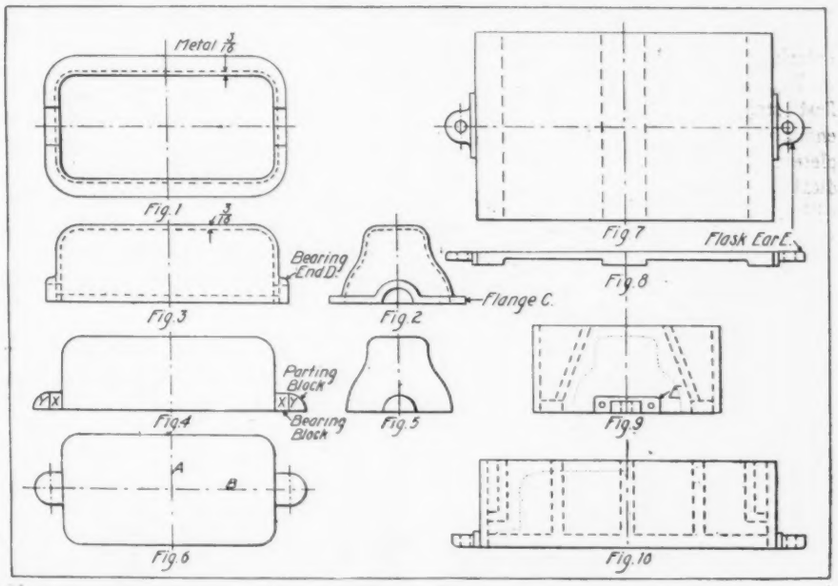
A Master Pattern for an Oil Pan

By John G. Koegle

While master patterns can be made in several ways, it is apparent that it would be difficult to build one over a form, of the automobile engine oil pan shown in Figs. 1, 2 and 3. It is customary to make a master pattern over a form of a section of this design, but the method which will be described herewith eliminated the use of a form, gave good results and saved considerable time. The oil pan was 3/16 inch thick, 27 inches long and 9¾ inches wide inside. In proceeding to make the master pattern a board shown in Figs. 7 and 8 first was made to which were attached ears *E*, on which were scribed center lines. After varnishing, this board was completed. It was used for both cope and drag. Next a form was made as shown in Figs. 4, 5 and 6. The bearing blocks *X* and *Y*, Fig. 4, were next attached with screws which were inserted through the reverse side of the board shown in Fig. 7. The form was varnished and a uniform coat of vaseline was spread over its entire surface.

A frame, as shown in Figs. 9 and 10, then was made and built-in as indicated by the dotted lines, which left a thickness of 2½ inches for plaster of Paris. The flask ears *E* were next attached. This frame then was placed over the form on the board shown in Fig. 7, flask pins inserted and clamped to the board. The plaster of Paris then was poured into the opening in the frame and when set, the board and the frame were rolled over, the screws removed and the board lifted off. After inserting several lag screws, the form was rapped and lifted from the plaster. The plaster then was washed with gasoline, to which was applied a light coat of yellow shellac. This operation completed the drag half.

Next, center lines were scribed on a piece of stock 3/16 inch thick, 27⅜ inches long and 10⅛ inches wide, the latter being the outside dimension of the oil pan. This was next located on the board, Fig. 7. From the form shown in Figs. 4, 5 and 6 the parting and bearing blocks were removed and the forms were cut on lines *A B*. Pieces 3/16 inch thick were added to the outside dimensions and the space filled-in then was ⅜ inch thick plus the saw cut. The bearing end *D* and the parting blocks *Y* then were added, which were the same as used for the drag. Flange *C*, Fig. 2, then was built-on and the form was ready for molding the cope, which was proceeded with in the same manner as the drag was molded.



HOW TO MAKE MASTER PATTERN FOR AN AUTOMOBILE ENGINE OIL PAN

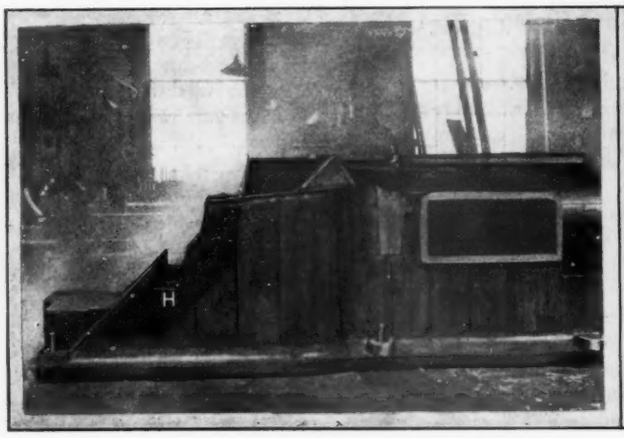


Fig. 1—Part of Engine Frame Pattern

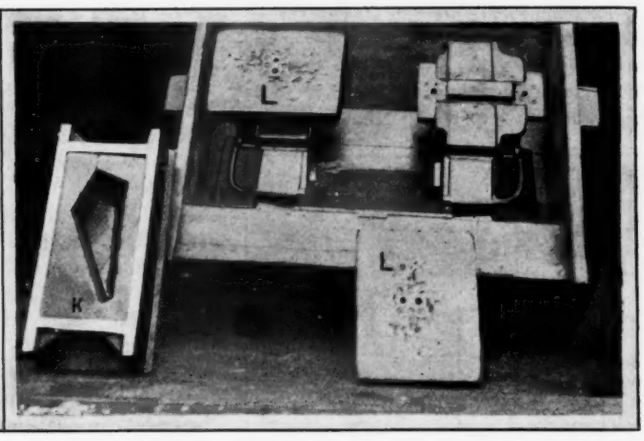


Fig. 2—Bearing Core Box

Making the Pattern for an Engine Frame

By E W Wallbank and E F Weinman

THE method of making an engine frame pattern, described herewith, is the outgrowth of a series of careful experiments, and some of the principles involved are not followed in ordinary foundry practice.

The design of both the interior and exterior of the casting is clearly shown in Fig. 3. In making the pattern, the first step is to secure a board large enough to permit laying-out the complete pattern with all core prints and indicated finish. This board is covered with a coat of yellow shellac. A second coat is applied between all lines denoting metal, thus avoiding all cross hatching. A shell pattern is constructed, necessitating the use of a form to give sufficient strength while ramming. This form is built along the line *ZZ*, Fig 3. A ½-inch strip of 1/32-inch gasket paper is tacked around the upper and lower edges of the form. This paper, after being treated with a coat of yellow shellac to prevent the adherence of any glue, will allow ample clearance for removing the pattern from the form. The pattern is built upon a strong framework, provided with vertical lagging as shown in Fig. 1. The bosses *Y* are inserted to the same depth as the flange. The neck *W*, shown in section *B*, is formed of segments, glued together, and then turned to size. The core print *V*, shown in section *A*, also is built-up of segments. Before turning this core print, however, a 3/16-inch temporary strip is placed between the halves. The core print then is turned ¼-inch larger in diameter than the actual size of the core. The print thus has the form of an ellipse, and any possibility of crushing when closing the mold is avoided. The core print *V* is then located on neck *W*. This portion of the pattern is left loose along the line *TT*, permitting this end to be lifted out after the pattern has been removed from the mold. The barrel, as shown in section *C*, is constructed from the line *TT* to the center of the

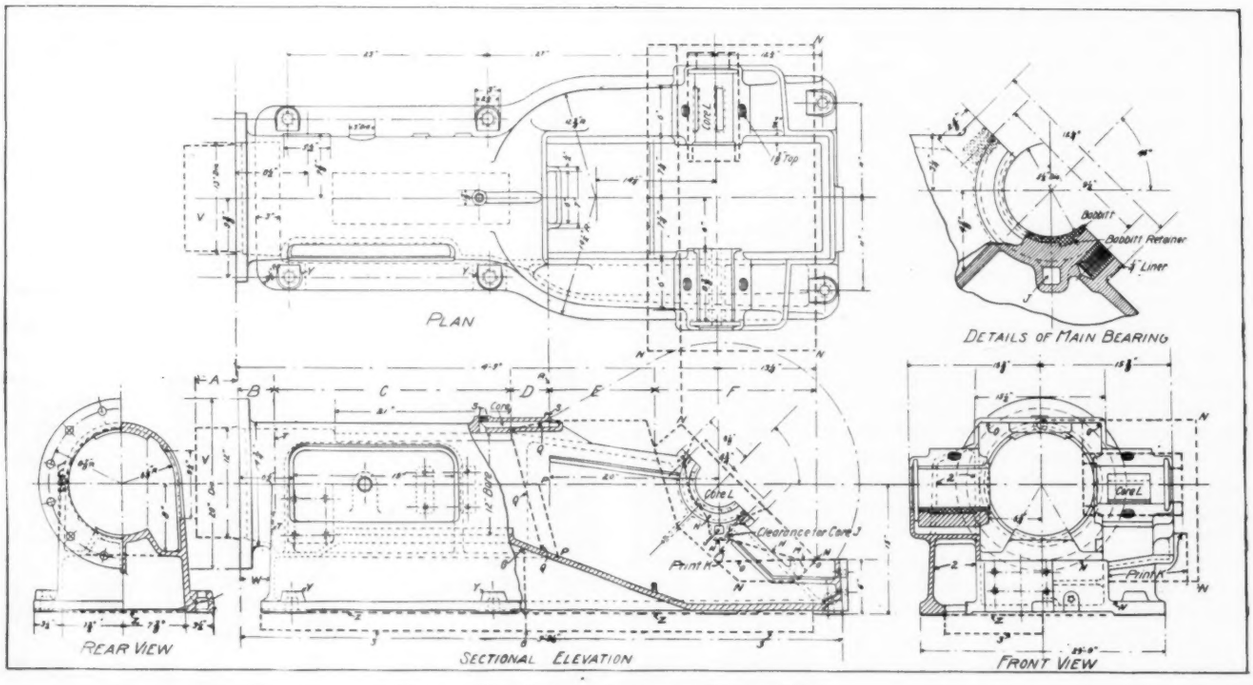


FIG. 3—DETAILS OF ENGINE FRAME

core print *S*. The barrel is staved up lengthwise and joins the lagging 3 inches above the center. Section *D*, comprising that part of the pattern between the print *S* and the line *R*, is glued up with thin layers of material, ranging in thickness from 1½ to 2 inches. After this section has been properly shaped, templates are made to insure uniform metal. The small core which fits into print *S* is made in a separate box. Section *E* then is properly formed inside and outside. All pads, bosses and core prints are then located and the pattern is complete.

The next step is the making of the core boxes, the methods followed being a distinctive feature of our pattern shop practice. The crosshead guide core is made in halves. It extends from the end of the print *V* to the line *QQ*. For about 2 inches on either side of the center line, this core is extended to the line *PP*. This extension is solely for location purposes. The main core is built up to line *QQ*, intersecting line *R*, and terminating in a core print which forms a recess for receiving the extension on the crosshead guide core.

Securing Satisfactory Bearings

Numerous experiments were made to determine the best method of securing satisfactory bearings on these castings. Difficulty was encountered, due to the straining of the mold, which caused the bearings to spread apart. The following method was finally evolved and has given satisfactory results. All bearings are made in a core, as shown in section *F*. The box is built along line *OO*, on the inside of the pattern between bearings. The box then follows the line *NN*, a piece being dropped in to bring the center up to *M*, the bottom of the box. The bearings are located in their proper positions with a print *L*, situated on the top and ends. Core print *K* is placed under the bearings and reaches to the top of the oil runner. As this core takes care of the oil runner, it is pasted into the bearing core before the latter is placed upon the pattern. The core *L* includes the crank bearing, oil groove *J*, and core prints for locating the babbitt retainer cores. These cores are made in a separate box and then are pasted in place in core *L*. The oil hole *J*, which is made on core *L*, drops into the clearance under the bearing, as shown at *H*, Figs. 1 and 3. The internal cores for decreasing the weight of the casting, are indicated by lines *2-2* and *3-3*. By bringing these cores to the line *3-3* all the equipment necessary for lifting can be placed readily, the cores being rammed in the cope and lifted like green sand cores. The cores are split along the line *GG* to facilitate handling.

Figuring Cupola Charges

By W A Ballou

FOR some time I have felt that foundrymen have experienced unnecessary difficulties in proportioning their charges. So far as I am aware, most foundrymen mix their irons by the method of trial and error, with the exception of the very few who resort to the tedious and rather difficult method of indeterminate equations.

The following method to be outlined is absolutely accurate and has the advantage of immediately giving a mixture with the required percentage of silicon. Also, this mixture may be held while the percentage of sulphur, phosphorus or manganese is raised or lowered, as the case may require.

To consider a simple example, it will be assumed that a foundryman has pig iron *A* containing 2.13 per cent silicon and pig *B* containing 3.15 per cent silicon. He wishes to mix these two pigs in such proportions as to make an iron containing 2.62 per cent silicon after allowing for 0.25 per cent loss during melting.

The solution follows: Add 0.25 per cent to 2.62 per cent, thus obtaining 2.87 per cent which is the amount of silicon to be put in the cupola. Arrange the percentage of silicon in the constituent pigs and the percentage in the mixture, as shown in the following table:

	I	*II*	*III*	*IV*	*V*
Pig *A*		2.13			
Mixture	2.87				
Pig *B*		3.15			

Subtract 2.13 from 2.87 obtaining 74 which is placed in column *III* opposite pig *A*. Also subtract 2.87 from 3.15 obtaining 28 which is placed in column *III* opposite pig *B*. The solution will then appear:

	I	*II*	*III*	*IV*	*V*
Pig *A*		2.13	74		
Mixture	2.87				
Pig *B*		3.15	28		

The next step in the process is to obtain column *IV* by interchanging, or inverting the figures in column *III* and placing them in column *IV*:

	I	*II*	*III*	*IV*	*V*
Pig *A*		2.13	74	28	
Mixture	2.87				
Pig *B*		3.15	28	74	
				102	

Adding column *IV*, 102 is obtained. Column *IV* gives the required mixture of the two pigs and may be interpreted in this way: If 28 pounds of pig *A* are mixed with 74 pounds of pig *B* one will obtain 102 pounds of a mixture containing 2.87 per cent of silicon, which mixture upon losing 0.25 per cent in melting will run an iron containing the desired 2.62 per cent silicon.

Proving the Problem

By way of proof we may further examine this solution. Twenty-eight pounds of a pig containing 2.13 per cent silicon will contribute to the mixture 28×0.0213, or 0.596 pound of pure silicon, while 74 pounds of a pig containing 3.15 per cent of silicon will contribute to the mixture 74×0.0315, or 2.335 pounds of pure silicon. This makes a total of $0.596 + 2.335$ or 2.93 pounds of pure silicon in 102 pounds of iron. Then $2.93 \times 100 \div 102$ will give 2.87 per cent silicon which, when reduced 0.25 per cent lost in melting will give the desired 2.62 per cent of silicon.

Furthermore, a foundryman desiring to make up a charge of 500 pounds would figure as follows:

$$\frac{28}{102} \times 500 = 137 \text{ pounds of pig } A$$

$$\frac{74}{102} \times 500 = 363 \text{ pounds of pig } B$$

500 pounds mixture which will run 2.62 per cent silicon.

If the mixture is desired on the percentage basis— $\frac{28}{102} \times 100 = 27.4$ per cent of pig *A* and $\frac{74}{102} \times 100 = 72.6$ per cent of pig *B* to make 100 per cent or the charge that will run 2.62 per cent silicon.

Again the following grades are available:

	Silicon, Per Cent.	Sulphur, Per Cent.
Pig No. 1.....	2.80	0.04
Pig No. 2.....	2.96	0.03
Scrap	2.70	0.08
Desired to run.....	2.65	0.07

Silicon to lose 0.25 per cent and sulphur to gain 0.04 per cent during the melt.

Add 0.25 per cent to 2.65 per cent giving 2.90 per cent silicon in the mixture for the charge. In column *I* place the percentage of silicon, namely 2.90 per cent. In column *II* place the percentages of silicon in the irons to be mixed, arranged in order from the pig containing the greatest percentage of

silicon down to the scrap containing the least:

	I	*II*	*III*	*IV*	*V*	*VI*
Pig No. 2.....		2.96	6	20	10	30
Mixture	2.90					
Pig No. 1		2.80	10		6	6
Scrap		2.70	20	6		6
						42

How the Example is Solved

To obtain column *III*, subtract 2.90 from 2.96 and place 6 opposite pig No. 2; subtract 2.80 from 2.90 and place 10 opposite pig No. 1; subtract 2.70 from 2.90 and place 20 opposite scrap. To obtain column *IV* interchange the positions 6 and 20 of column *III*, placing 20 opposite pig No. 2 and 6 opposite scrap. To obtain column *V*, interchange the positions of 6 and 10 of column *III*, placing in column *V*, 10 opposite pig No. 2 and 6 opposite pig No. 1. Column *VI* is obtained by adding sideways columns *IV* and *V*. Column *VI* gives the required mixture and may be interpreted in this way: If 30 pounds of pig No. 2 containing 2.96 per cent silicon are mixed with 6 pounds of pig No. 1 containing 2.80 per cent silicon and 6 pounds of scrap containing 2.70 per cent silicon, there will be obtained 42 pounds of mixed irons containing 2.90 per cent silicon that will run 2.65 per cent silicon when it loses 0.25 per cent in melting.

This may be checked exactly as follows:

	Per Cent.	Pounds Silicon.
Pig No. 2 30	× 2.96 =	8.88
Pig No. 1 6	× 2.80 =	1.68
Scrap 6	× 2.70 =	1.62
Mixture 42	× 2.90 =	12.18

	Per Cent.
Pig No. 2..... $\frac{30}{42} \times 100$ =	71.4
Pig No. 1..... $\frac{6}{42} \times 100$ =	14.3
Scrap ..... $\frac{6}{42} \times 100$ =	14.3
	100

or the whole charge.

Ascertaining the Sulphur

Next consider the sulphur:

	Pound Sulphur.
Pig No. 2.....30 × 0.0003 =	0.0090
Pig No. 1..... 6 × 0.0004 =	0.0024
Scrap ..... 6 × 0.0008 =	0.0048
Total ..... =	0.0162

in 42 pounds of mixed charge.

This figures $\frac{0.0162}{42} \times 100 = 0.0386$ per cent sulphur.

As the sulphur gains 0.04 per cent in melting it should mix to 0.07 per cent, 0.04 per cent or 0.03 per cent. It is obviously impossible to make such a mixture as the lowest sulphur value is that of pig No. 2 which, if melted alone, would run 0.07 per cent. It is evident that the sulphur value of the mixture will be raised in proportions to the amounts of the other pigs placed in it on account of their having sulphur values in excess of 0.03 per cent. However, if the sulphur value for the mixture as obtained in the foregoing example needs to be lowered it may be done, to a limited extent, as follows:

	IV	*V*	*VII*	*VIII*	*IX*
Pig No. 2.....	20	10	10	30	40
Pig No. 1.....		6		18	18
Scrap	6		3		3
					61

It will be noted in the original example that the scrap has the largest percentage of sulphur. Therefore, if the proportion of scrap in the mixture is reduced, the percentage of sulphur will be lowered. Column *VII* is obtained by dividing column *IV* by 2; column *VIII*, by multiplying column *V* by 3; and column *IX*, by adding columns *VII* and *VIII* sideways thus obtaining a new mixture that will still run silicon, 2.65 per cent and the sulphur value will be lowered. This is solved as follows:

	Pound Sulphur.
Pig No. 2.....40 × 0.0003 =	0.0120
Pig No. 1.....18 × 0.0004 =	0.0072
Scrap ..... 3 × 0.0008 =	0.0024
	0.0216

in 61 pounds of charge or $\frac{0.0216}{61} \times 100 =$ 0.0354 per cent sulphur against 0.0386 given by the first mixture.

Any reasonable number of pigs may be handled in this manner. Also having obtained a desirable mixture for the most important constituent, this proportion may be held while the other constituents are arranged.

When embodying this method, certain principles are to be borne in mind. Arrange the pigs in order of the percentages of the constituent they contain and place the mixture in its proper place in the arrangement. In the subsequent adjustments intermediate columns, such as *III* and *IV* may be multiplied or divided by any number, thus changing the proportions without deranging the mixture obtained.

It also should be remembered that this method will not accomplish the physically impossible; however, it will immediately show that the desired mixture is impossible if such is the case. That is, a satisfactory mixture is possible only when the desired percentage lies between the percentages of the element in the highest and lowest of the pigs.

For those whose minds run to abstractions, all of the foregoing may be summed up in the one statement, namely, that the amount of any constituent entering into a given mixture is inversely proportional to the distance the constituent's strength is from the mixture strength.

Coal for Malleable Work

By F Van O'Linda

THE malleable iron manufacturer has an interest in coal which is threefold: First, it melts his pig iron, sprues and scrap in the air furnace and brings it to a condition for casting; second, it anneals the hard iron casting, and third, it furnishes power for numberless operations in his foundry.

However, the use of coal for melting only will be discussed. Coal for air furnace use must be low in sulphur and phosphorus, high in volatile matter, combustible and should carry a long, hot flame. When firing, it is preferable to throw the coal directly onto the fire instead of coking it in front of the door, and since during the first three or four minutes the coal is giving off its heavy gases, plenty of air should be admitted at this time. If possible, the bottom wind should be partly cut off after these heavy hydro-carbons are diven off, because otherwise the excess air will pass through the furnace and out of the stack taking heat with it. No advantage is to be obtained from coking the coal before spreading it on the fire, thereby making two operations of one. Coal should be spread from the shovel when firing, but if coke is desired, why not fire coke in the first place? Air furnace melting requires flame, and coke is a short flame fuel. I cannot agree with those who claim that radiation plays an all-important role in the air furnace. It has its part in the melting operation, but flame is absolutely necessary, or otherwise the low volatile smokeless coals from Maryland and West Virginia which give off great heat, but little flame, could be used. Some furnaces will melt satisfactorily, but are slow in heating the iron, and in almost every case this is due to a short flame or the flame passes high in the furnace and does not sweep down upon the bath.

Too much coal should not be fired at one time; three or four shovelfuls spread on the fire every three minutes give good results as the practical banking of a fire by covering up all the incandescent coal gives a heavy, smoky flame, with low available heat value in this practice. For the complete combustion of each pound of

From a paper presented at the Atlantic City meeting of the American Foundrymen's Association.

coal, 15 pounds of air are required, and with frequent firing, the coal and air supply are more nearly equal. The placing of the top wind is important. If the pipes point directly down into the furnace, the air forms a screen through which the flame has to break. The pipes should be so placed that the blast follows the course of the flame and becomes a part of it. When the flame is held low in the furnace it will cut through the pig and sprue during melting instead of hurdling over it. The heat also will be shortened for the flame will hug the iron, causing it to heat quickly and at the same time it will cover the bath and prevent oxidation.

Phosphorus and Sulphur Content

The phosphorus and sulphur content of the coal should be low. While sulphur has considerable heat, it is an element to be avoided in air furnace practice. Ash is the non-combustible residue left when the fuel is burned. Some coals show less than 3 per cent, while others may contain as high as 15 per cent of non-combustible matter.

The United States government counts this negative value at 2 cents per ton for each per cent of ash above the standard ash established for a particular specification. Let us see how this would work out for a foundry buying its coal not on cost, but on efficiency. "A" bids $1.30 per ton at the mines for coal having a heating value of 14,648 B. T. U.'s with ash at 3 per cent. "B" bids $1.20 for coal having 14,000 B. T. U.'s with ash at 6 per cent; and "C" bids $1.10 for coal having 13,700 B. T. U.'s with ash at 9 per cent. Taking the lower ash, 3 per cent, as the standard, the 3 per cent excess in ash of "B" is equivalent to 2 cents per ton on the bid price so "B" is raised to $1.26 and "C", with 6 per cent difference, is raised to $1.22. The cost per million B. T. U.'s on the foregoing grades of coals, therefore, would be as follows:

$$\text{"A"}\ \frac{\$1.30 \times 1000000}{14648 \times 2000} = \$0.0443$$

$$\text{"B"}\ \frac{\$1.26 \times 1000000}{14000 \times 2000} = \$0.045$$

$$\text{"C"}\ \frac{\$1.22 \times 1000000}{13700 \times 2000} = \$0.0445$$

How it Works Out

Although as originally bid "A" was 10 cents per ton higher than "B", and 20 cents per ton higher than "C", it is thus shown that "A", the supposed highest bidder, was in reality the lowest bidder when true values are considered, and if each per cent of ash is a difference of 2 cents per ton in Pennsylvania, what would it be on the same coal shipped to Chicago or beyond? In consideration and pursuance of these true values better results in the burning of coal in the air furnace will be brought about.

Cast Iron Billets for Repair Shop Use

By William Phillip

SOME years ago, a certain large industrial plant having its own machine and repair department, had no pattern-maker and in many instances there was not sufficient time for making patterns or sending for new parts. It was generally a case of repair at once, so when we had a breakdown we usually picked up a piece of machine steel and cut out the gear, bracket or cam, or whatever the broken part happened to be. If there was no machine steel at hand and tool steel was available, we used that. After a time, the powers that be came to the conclusion that the use of this steel was a needless expense. As an alternative, the use of cast iron billets, both round and rectangular, was suggested, but none could be obtained. We then decided to cast our billets and made some rough patterns to suit our needs. Different sizes were added from time to time, but after two years we had sufficient sizes to cover our requirements. The accompanying chart shows the sizes and styles we use.

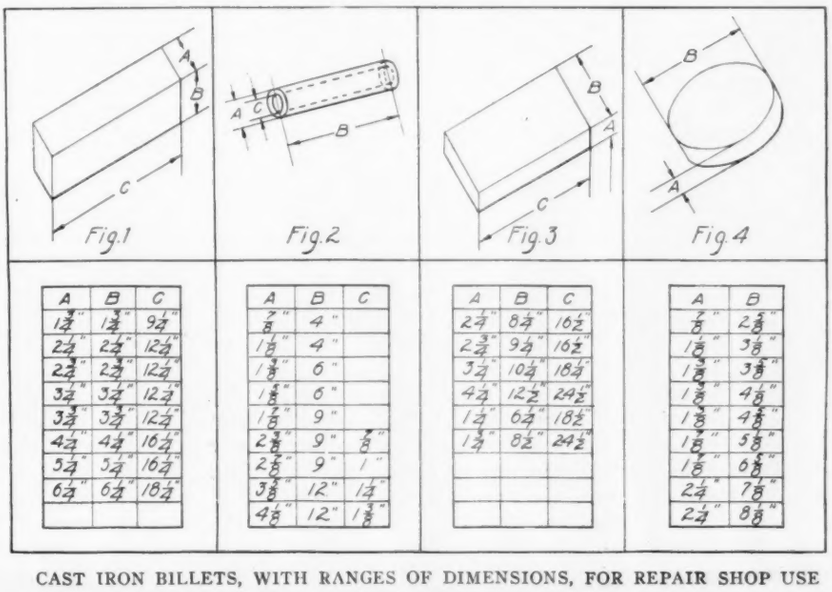
All are cast iron, Fig 2 also being cast in bearing bronze, as we use quite a few bronze and cast iron bushings, rollers, etc.

The saving in the cost of material is apparent. Cast iron, at from 3 to 6 cents a pound and machine steel and tool steel at from 15 to 60 cents a pound, represents a material saving. The machining operations also are a factor, as it is much easier to machine cast iron than machine and tool steel.

These shapes will be found handy in the average small machine and repair shop and can be used for a class of work, where at present, machine and even tool steel is used for no other reason except that it is at hand or easily obtained without loss of time, whereas cast iron billets cannot be purchased in the open market.

And now the question arises, "Why are not simple, small sections of cast iron available?" Is there any reason why our foundries or jobbers should not carry some sizes of cast iron sections? They may say they have had no demand for them, but we do not ask for something that is not on the market and which we are certain we cannot obtain. Let the trade know that cast iron can be bought in shapes and sizes handy for the small shops and it soon will be apparent to many small shop owners that they can save money by using cast iron for some of the work for which they now are using steel.

Foundrymen, get wise, standardize and advertise.



A	B	C
1 1/2"	1 1/2"	9 1/4"
2 1/4"	2 1/4"	12 1/4"
2 1/2"	2 1/2"	12 1/4"
3 1/4"	3 1/4"	12 1/4"
3 1/2"	3 1/2"	12 1/4"
4 1/4"	4 1/4"	16 1/4"
5 1/4"	5 1/4"	16 1/4"
6 1/4"	6 1/4"	18 1/4"

A	B	C
7/8"	4"	
1 1/8"	4"	
1 1/8"	6"	
1 1/8"	6"	
1 1/8"	9"	
2 1/8"	9"	1/8"
2 1/8"	9"	1"
3 1/8"	12"	1 1/4"
4 1/8"	12"	1 1/8"

A	B	C
2 1/4"	8 1/4"	16 1/2"
2 3/4"	9 1/4"	16 1/2"
3 1/4"	10 1/4"	18 1/2"
4 1/4"	12 1/2"	24 1/2"
1 1/4"	6 1/4"	18 1/2"
1 3/4"	8 1/2"	24 1/2"

A	B
7/8"	2 3/8"
1 1/8"	3 3/8"
1 1/8"	3 3/8"
1 1/8"	4 3/8"
1 1/8"	4 3/8"
1 1/8"	5 3/8"
1 1/8"	6 3/8"
2 1/4"	7 3/8"
2 1/4"	8 3/8"

CAST IRON BILLETS, WITH RANGES OF DIMENSIONS, FOR REPAIR SHOP USE

Keeping Systematic Costs in a Jobbing Shop

A Simple Method Adapted to the Small Foundry Which Can be Installed at a Minimum Cost and Operated Economically

By John S Watts

THE average small foundry doing a varied class of jobbing work does not usually attempt to accurately find the cost of the various castings it produces, being content to take the total cost on all work done each month and to use this as a basis for a price per pound on all kinds of castings.

It is well-known to all practical foundrymen that this method of charging the same or nearly the same price per pound for castings weighing from a few ounces to as many tons is neither fair to the customer nor profitable to the foundry. Some attempts have been made to have the pound price vary for the different weights of castings, but while an approach towards accuracy, this method is still far from correct, as it takes no account of the number of cores to be made, nor the area of the flask required to take in the pattern.

CUPOLA REPORT — DATE OF CAST

MATERIAL	GRADE	WEIGHT	COST PER CWT.	COST
PIG IRON	Dominion	1500	95	14 25
	Hamilton	3000	95	28 50
SCRAP	Car Wheel	1500	80	12 00
	Foundry	1000	00	
TOTAL WEIGHT OF IRON		7000		
FUEL	Pennsylvania	600	45	2 70
	Drummond	200	28	56
TOTAL WEIGHT OF FUEL		800		
LIMESTONE, SAND, FACING, ETC., AT 1/10 CT. PER LB. CASTING		50	12	06
				6 30
TOTAL COST OF MATERIAL				64 37

WEIGHT OF IRON MELTED / WEIGHT OF FUEL = 7000 / 800 = 8.75

FIG. 1—CUPOLA REPORT

In passing it may be mentioned that the area of the flask needed for a casting has as much or more to do with the cost of molding than its weight, other things being equal.

Probably the nearest possible approach to accuracy in estimating the cost of a casting would be attained by charging a price per pound plus a price per square inch of area of a rectangle into which the casting would go, with a further addition for cores and for castings requiring a three-part flask.

To be able to fix prices for the various types of castings in accordance with the foregoing suggestion we must know more about their actual cost of molding than the present system of computing the total cost of all the castings will enable us to find.

Method Suggested

The method given here is simple and takes very little time to handle and need not cause any addition to the bookkeeping cost. First, we have the usual cupola report which can be made out by the cupola man or the foundry foreman, and may be about as shown in Fig. 1. It will be noted that the foundry scrap is accounted as being of no value, it being assumed the gates, etc., left over from each cast will be about equal to the foundry scrap charged in the cupola, that is, this item is regarded as a sort of nest egg. Of course, it could be arranged to weigh up the gates, etc., from each cast, but it would cost more than the slightly greater accuracy in the casting would be worth. The last item, "sand and facings, etc., at 1/10 cent per pound of castings" can be checked for correctness by taking the total cost for these supplies each year and dividing by the total amount of iron melted that year. It is obvious that the cost of sand, facings, etc., will vary, very nearly as the amount of iron melted.

We now have the total cost of all the materials used and will next take up the labor charges which is really the only awkward part of the problem. If it were possible for a molder to fill out a time sheet such as is used by other mechanics the whole matter would be settled at once. But as he usually spends considerable time mixing sand, pouring-off, etc., which time cannot be accurately apportioned among the various castings, and as he may often have more than one kind of casting in the same flask, it is impossible to know just how much time each casting should have charged against it.

The nearest we can get at it with any degree of accuracy is to take each molder's output of castings, every cast, and charge against them his time, plus his percentage of the helper's and foreman's time. The cost of the material being added, the total will be the net cost of that lot of castings. By adding the overhead charges we have the selling price we should have for that lot and a comparison with the actual selling value will show whether we are getting enough or not. Should the sale price be too low it is usually very easy to locate the casting or castings that are too costly to make at the price and subsequent casts which will have different combinations of castings will further identify the unprofitable casting by causing a loss every time it is made.

In order to have each molder's output separated, we can use the usual casting sheet, with the addition of one column giving the name of the molder who molded it. A sample casting sheet is shown filled out in Fig. 2. From this we get out cost sheets as shown in Fig. 3, which is also filled out for the same cast as the other two figures.

DAILY FOUNDRY REPORT — DATE OF CAST

NO. PIECES	DESCRIPTION	ORDER NO.	PATTERN NO.	WEIGHT	MOLDER	DEFECTIVE
1	Die	5028		490	H.S.	
2	Grate Bars	4814		560	J.C. J.A.	
2	" "	"		575	"	
1	Scraper Plate	5020		21	G.P.	
18	Pipe Rests	4584		125	"	
1	Die	5028		134	W.B.	
4	"	"		223	"	
201	Curl Washers	4935		238	K.S.	
1	Liner	4944		23	"	
2	Pipe Flanges	5034		45	W.D.	
4	Nuts	5020		44	"	
2	Fire Doors	4944		80	G.P.	
1	Grader Grate	4827		147	"	
4	Pipe Flanges	5064		56	"	
1	Reducer 8" to 6"	5019		129	W.M.	
1	10"x10"x6" Tee	"		388	"	
1	Die	5028		1165	"	
1	Die	5033		620	"	
2	Ash Doors	4994		69	J.C. J.A.	
1	Hopper Back	4815		390	H.S.	
2	Grate Bearers	4827		187	"	
2	Brackets	5065		171	G.P.	
9	Pipe Sleeves	4765		383	W.B.	
1	Ring	5080		27	"	
3	Couplings	5020		26	"	

FIG. 2—MOLDERS' DAILY CASTING REPORT

Pick out from the casting sheet each molder's castings and from the time book the amount of time credited to him for this cast, leaving a line between each molder's set of castings for the totals. Next go through the time book or payroll and place at the lower part of first columns of the cost sheet all the other men on the foundry pay roll, that is helpers, cupola men, foreman, etc., with their respective hours and rates, extending the totals for molders into the column headed "direct labor". These columns

should be totaled at the bottom and added together to give total labor cost for the whole cast.

We can now distribute the indirect labor cost among the molders by adding to their wages the percentages that the total indirect labor is of the total direct labor, the result being the total labor cost for each molder's lot of castings.

To find the material cost we add the total weight of castings produced and divide the total cost of material, Fig. 1, by the total weight of castings, which will give the cost of material per pound of castings. Next, add each molder's castings, as in Fig. 3 and multiply by cost of material per pound, placing the total in the "cost of material" column opposite the molder's name. Add the "cost of material" to the "labor cost" and place the total in the "total cost column". Under "castings" in Fig. 3, fill in "price per pound" (i. e., actual selling price) and extend the total into "total value" column, adding up for each molder to find the total value of all castings produced by him, and from this deduct his "total cost"; the balance will be the "gross profit" and is shown in this column.

Profits and Losses

The last column shows the gross profit divided by the total labor cost, and should, in the example shown, be 100 per cent, this being the overhead charges reckoned as a percentage of the wages. All these columns are totaled at the bottom and show whether the cast as a whole has paid. At the same time the $\frac{\text{gross profit}}{\text{wages}}$ column shows where the losses and profits have been made and steps can be taken to either raise the price, or if this cannot be done, drop the unprofitable castings.

The writer has used this method for some time and can say that it will certainly show some surprising facts to any foundry owner or manager who has not hitherto used a similar system. The slide rule should be used in all the calculations as the answers are nearly always in three figures and the slide rule is quite sufficiently accurate. By its use the whole cost sheet can be easily made up in half an hour.

At the annual meeting of the stockholders of the American Metal Products Co., Milwaukee, officers were re-elected as follows: Peter J. Weber, president; Henry C. Brelie, vice president; William J. Eberle, secretary and treasurer, and Richard Gaertner, general manager. The foregoing officers with Charles E. Helm and August Littmann constitute the board of directors. The recent purchase of a larger plant and additional equipment was ratified.

Yellow Brass Difficulties

By C. E. Lyall

On page 76 of the February number of *The Foundry* was published an inquiry with reference to difficulties experienced in making yellow brass castings containing a ½-inch ridge, without the use of pegs or a dry sand core. I have made yellow brass plates with 54 ridges on the cope side and the same number on the drag which weighed 450 pounds each and no difficulty whatever was experienced with the ridges washing away. The ridges should not be rammed too hard nor should the sand be worked too wet. A facing sand should be made consisting of eight heaping shovelsful of dry sand from the heap and one shovelful of seacoal. This should be mixed thoroughly while in the dry state and should be passed through a fine screen. After screening, it should be wet down with a solution consisting of 50 parts of molasses and 50 parts of water. This then should be screened again and used for facing the ridges. If the castings are round the pouring gate should be cut into the periphery of the mold to insure the easy flow of the metal over the ridge, and if the casting is square, the gates should be cut into two adjacent corners. By following this method we have experienced practically no difficulty in making castings containing ridges.

Ferro-Manganese During the War

As a result of the war, the sources of manganese imports into the United States have been greatly changed. For three years prior to 1915 India supplied slightly more than one-third the imported tonnage, which averaged 309,682 tons a year, while Russia and Brazil supplied about equal parts of the remainder. During the first ten months of 1915, Brazil supplied 181,258 tons out of a total of 192,286 tons. Under normal conditions in the United States, about one-half of the supply of ferro-manganese is imported and the other half is smelted largely from imported ores. The restrictions placed by India upon exports of ferro-manganese during the first six months of 1915 greatly reduced the imports into the United States. For the first nine months of last year the imports were 40,863 tons, compared with 62,333 tons for the same period of 1914 and 99,752 tons for the same period of 1913. During the year the price of ferro-manganese advanced from $70 a ton in January to $115 a ton in December.

FOUNDRY COST SHEET

CAST DATE.....

NAME OF MOLDER	HOURS	RATE	WAGES DIR	WAGES IND.	TOTAL LABOR COST	NO. CYS	NAME OF CASTING	ORD. NO.	TOTAL WT.	PRICE PER LB.	TOTAL VALUE	COST OF MAT'L	TOTAL NET COST	GROSS PROFIT	G.P. WAGES
H.M.D.	21	.27½	5.77		9.60	1	Die	5038	490	2½	12.25				
						2	Grate Bearers	4927	187	"	4.68				
						1	Hopper Back	4985	390	"	11.70				
									1067		28.63	10.90	20.56	8.13	85%
H.C. & J.A.	21	.25	5.25			4	Grate Bars	4984	1135	3	34.05				
	21	.07	1.47		11.10	2	Ash Doors	4990	69	2½	1.73				
			6.72						1204		35.78	12.30	23.40	12.38	111%
						1	Die	5033	670	2½	16.50				
W.M.	21	.26	5.46		8.73	1	Die	5028	1155	"	28.88				
						1	10"x10"x6" Tee	5019	388	3	11.64				
						1	Reducer 8" to 6"	"	129		4.00				
									2292		60.02	23½	37.13	27.89	370%
G.P.	21	.26	5.46		8.73	1	Scraper Plate	5020	21	2½	.53				
						18	Pipe Racks	4584	125		5.45				
						2	Brackets	5065	171	2½	4.28				
						4	Pipe Flanges	5064	56	"	1.40				
						1	Circular Grate	4827	147	3	4.41				
						2	Fire Doors	4944	80	2½	2.00				
									600		18.07	6.12	14.85	3.22	37%
W.D.	21	.26	5.46		8.73	1	Die	5023	134	2½					
						4	"	"	223	"					
						9	Pipe Sheaves	4985	383	"					
						1	Plug	5080	27	"	22.05	9.00	17.73	4.32	49%
						2	Couplings	5070	26	"					
						4	Nuts	"	44	"					
						2	Pipe Flanges	5034	45	"					
									882						
K.G.	21	.05	1.05		1.75	201	Bevel Washers	4935	238	2½					
						1	Liner	4944	23	"	6.53	2.66	4.41	2.12	121%
									261						
R.J.M.	21	.35	7.35												
W.F.C.	21	.25	5.25												
H.G.	21	.17½	3.67												
J.D.	21	.15	3.15												
TOTALS			29.29½	1.46	48.71				6306		171.08	66.37	113.08	58.06	119

IRON: MELTED WT. OF CASTING = 7000/6306 = 110%

IRON/COKE = 8.75

AVERAGE WAGE PAID PER LB OF CASTINGS = 48.71/6306 = .77

MATERIAL COST PER LB OF CASTINGS (INCLUDES 1/10 CT. PER LB. FOR SAND, FACING, ETC.) = 64.37/6306 = 1.04

WAGES INDIRECT / WAGES DIRECT = 19.42/29.29 = 66⅔%

FIG. 3—FOUNDRY COST SHEET

THE FOUNDRY

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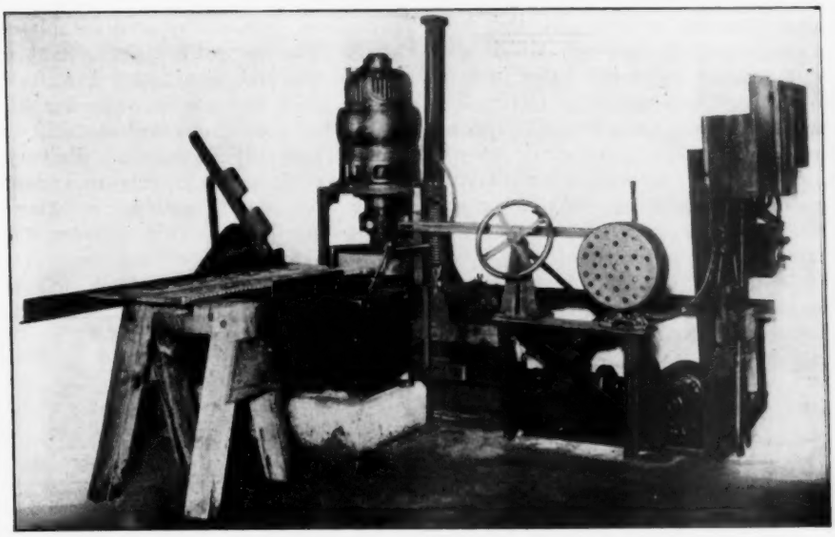
Trade Outlook

FOUNDRY operations generally continue at high pressure and the melt, since the first of the year has been at a record pace. Regardless of the prices asked for castings, users continue to crowd the shops for deliveries and premiums are commonly paid for early shipments. Concurrent with this activity is an unprecedented movement to increase melting capacity, in gray iron and steel shops particularly. The output of some plants, specializing in automobile work, when present extensions are completed, will be enormous, considered from the standpoint of the weight of the individual castings. One foundry in the Cleveland district, making cylinder castings, when present additions are finished, will have an output of 175 tons daily, and another in southern Michigan, engaged in a similar line of work, will have a daily melting capacity of 225 tons. These are enormous figures, and, in a measure, reflect what a tremendous feeder to the foundry trade the automobile industry today. Recent statistics issued by the census bureau record the manufacture of 573,114 automobiles in 1914, valued at $465,042,474. During this year 338 plants built automobiles complete, 38 of which were engaged primarily in the manufacture of bodies and parts, agricultural implements and other products, and reported the building of motor cars as a subsidiary line. The census of 1909 reported 315 establishments engaged in the manufacture of automobiles, with an output of 127,287 machines, valued at $165,099,404. Therefore, during the five years from 1909 to 1914, automobile production increased 350.3 per cent in number of cars and 181.7 per cent in their total value. These figures, of course, do not represent the product of the large number of concerns engaged in the manufacture of accessories and do not include the casting plants now specializing in motor car castings exclusively. While the figures for 1915 are not yet obtainable, it is certain that they will show a big increase over 1914, and from present indication, 1916 will greatly surpass all previous records. Not alone are the gray iron and steel shops benefited by the growth and activity of this industry, but the malleable plants are making many parts formerly cast in gray iron and steel, while the tonnage of the brass and aluminum casting plants specializing in this work has attained almost unbelievable figures. The prosperity of the foundry trade today is without the usual large requirements for makers of agricultural implements and the railroads. If the demands of both of these were even up to normal needs, it is doubtful if the melting capacity of the country would be sufficient to take care of this trade. Casting production in the Pittsburgh district has been greatly reduced by labor difficulties and the indications point to a spread of this trouble during the spring months. Jobbing shops, largely dependent upon the steel plants and blast furnaces for the larger part of their business are flooded with orders for repair parts and the roll foundries report an unprecedented demand for their output. The question of an adequate supply of raw material for the remainder of the year is fast becoming acute and the heavy buying movement of pig iron during the closing weeks of February is indicative of the anxiety of foundrymen generally. In the leading centers, No. 2 is quoted as follows: Chicago, $18.50; Cleveland, $19.30; Buffalo, $18.50; Pittsburgh, $19.45; Philadelphia, $20, and Birmingham, $15 to $15.50. Malleable iron is held at $19.45, Pittsburgh.

New Equipment for Foundry and Pattern Shop

A Special Machine for Grinding Castings—Unloading Pig Iron With a Gravity Carrier—Jolt-Ramming Attachment—New Vibrator

A SPECIAL machine for grinding the ends of book stack castings, described in a recent number of *Grits and Grinds*, published by the Norton Co., Worcester, Mass., has been installed by the Snead & Co. Iron Works, Jersey City, N. J. Before this machine was designed, the ends of book stack castings, such as are used for uprights in library book stack construction, were ground on a rim wheel and machine similar to the ordinary type of vertical face grinder. Difficulties were experienced in securing accurate results owing to the wear in the thrust bearings on the grinder. Rapid wheel wear and excessive use of power were other objections to this method.



SPECIAL MACHINE FOR GRINDING THE ENDS OF BOOK STACK CASTINGS

The specially-designed machine, shown in the accompanying illustration, built by the Norton Grinding Co., Worcester, Mass., has made greater accuracy possible and has reduced wheel cost and power consumption. This machine mounts a 3½ x 20-inch wheel and requires about 7-horsepower to operate. It will turn out as much work as the 22-inch rim wheel formerly employed, which required 15-horsepower to operate.

The power is supplied to the wheel by a vertical motor, the wheel being mounted on a quill sliding on a feather in a vertical shaft directly coupled to the motor shaft. The grinding head is moved back and forth across the work by a worm and worm rack, driven by an auxiliary motor through a worm reduction. A cam mounted on the worm shaft and connected to a rocking lever moves the wheel up and down as it passes over the work. The weight of the wheel is balanced by a large vertical spring. The motor affecting the travel of the wheel is controlled by a reversing dial-type controller, automatic limit devices being placed so that the limits of travel will not be exceeded.

The first wheel mounted on the new machine was reduced in diameter only 1 inch after having been used six months, but in the same time three rim wheels would have been used by the method which was employed formerly. The machine is designed to grind surfaces up to 30 inches long and 3½ inches wide and is fitted only for dry grinding.

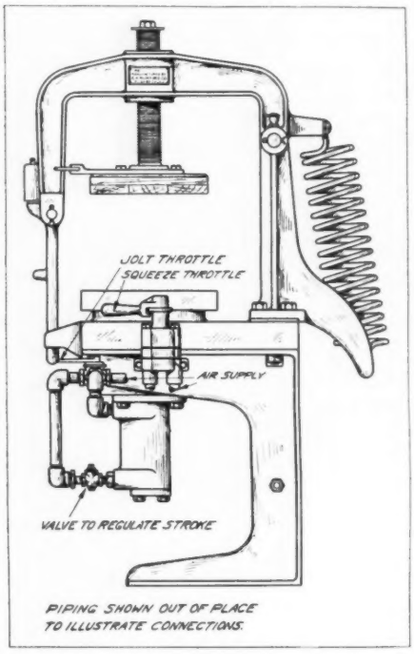
Unloading Pig Iron With a Gravity Carrier

To facilitate the unloading of pig iron from cars and to direct its delivery to almost any point in the stock yard where it is to be piled, the gravity carrier, shown in the accompanying illustration, effects big economies in the handling of this raw material. It is the customary practice to unload pig metal from cars into a pile at the side of the car and then to convey it in cars, or by hand, to a point in the yard where it is to be piled. The gravity carrier eliminates this unnecessary handling and the laborers unloading the pigs only are required to place them on the rollers of the carrier which delivers them to the point in the yard where they are to be piled.

The gravity carrier in the accompanying illustration was installed in the plant of the Standard Steel Castings Co., Cleveland. It is of a standard type utilized for handling pig iron and is equipped with 3¼-inch steel rollers made from hot rolled steel tubing No. 11 gage. These rolls are provided with detachable ball

MATHEWS GRAVITY CARRIER INSTALLED AT THE PLANT OF THE STANDARD STEEL CASTING CO. FOR HANDLING PIG IRON

bearings and are assembled in steel frames 6 feet long, the rolls being spaced 3½ inches from center to center. A guard rail is provided with a 12-inch clearance. As many units as may be required can be assembled to deliver the pigs from the cars to distant points in the storage yard. The carrier will operate on grades as low as 4 to 8 per cent, according to the character of the pig iron handled. Machine-cast metal can be delivered on a 4 per cent grade, while sand-cast pigs will require approximately an 8 per cent grade. In this illustration the pigs are of the sand-cast type. Ninety degree curves also are furnished to direct the line of the conveyor either to the right or left.



MUMFORD HIGH TRUNNION POWER SQUEEZER EQUIPPED WITH SPECIAL JOLT-RAMMING ATTACHMENT

By the use of this gravity carrier the stock yard force can be materially reduced and the handling of metal is greatly expedited.

Largest Bronze Groups Cast in This Country

A bronze cavalry group of heroic size for the General Grant monument at Washington, D. C., has been completed by the Roman Bronze Works, 275-289 Greene street, Brooklyn, and was exhibited to the public recently. The cavalry group, of which Henry Merwin Shrady is the sculptor and Edward Pearce Caset, architect, is 28 feet long, 10 feet wide, 12 feet high and weighs 31,400 pounds. Some time ago the Roman Bronze Works completed the artillery group, which is now in place on the Grant monument. This piece is 28 feet long, 10 feet wide, 11 feet high and weighs 28,600 pounds. These are the largest bronze groups ever cast and erected in America.

Jolt-Ramming Attachment for Power Squeezers

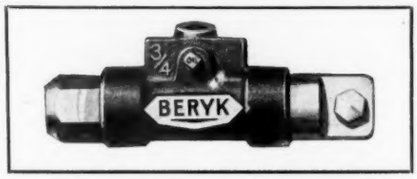
For the purpose of converting the Mumford high trunnion power squeezer into a combination jolt squeezer, a jolt-ramming attachment has been developed by the E. H. Mumford Co., Elizabeth, N. J. This attachment consists of a small jolt cylinder designed to fit underneath the squeezing cylinder of the plain power ramming machine, which contains a single piece jolt valve in combination with an operating piston. The method of attaching the jolt mechanism to the plain squeezer is clearly shown in the accompanying illustration. The squeezing and jolting operations are separately controlled and are entirely independent of each other. While the air supply pipe in the accompanying illustration is shown apparently in front of the machine, in reality it is at the right hand side and back of the front line of the frame. It is shown out of place for the purpose of illustrating the method of attaching the jolt cylinder. The addition of this feature to a plain squeezer greatly increases the scope of this machine since deeper and more difficult work can be handled to better advantage when the jolt-ramming feature is available. These attachments for plain machines will be furnished by the E. H. Mumford Co. with drawings and instructions for installing them, or the high trunnion type of squeezer, built by this company, will be furnished equipped with this jolting feature. The high trunnion type of squeezer machine manufactured by the Mumford company recently has been redesigned and 2 inches of space have been added behind the table, thereby increasing the flask capacity. The legs have been specially designed to facilitate the addition of the jolt feature at any time, and the cylinder construction also has been improved.

The C. F. Sammond Co., 84 Detroit street, Milwaukee, will represent the Hill & Griffith Co., Cincinnati, manufacturer of foundry facings and equipment and polishing and plating supplies, in Milwaukee and immediate vicinity.

"Tungsten, Its Properties and Uses" is the title of a booklet being distributed by Carlisle & Co., 74 Broadway, New York. In view of the present activity in the tungsten market and the scarcity of this metal, the booklet is exceedingly interesting and contains also extracts from an article prepared by Frank L. Hess for the United States geological survey.

Develops New Vibrator

The Beryk Co., 1265 West Second street, Cleveland, has developed a new vibrator which is furnished in all sizes from ½-inch upwards, making it possible to obtain a size suitable for any class of work. In addition to the regular lines carried by the company, a special light weight vibrator in ½ and ⅝-inch sizes, weighing only 18 ounces, is manufactured for plated work. The company makes vibrators exclusively and vibrators taken from stock, which ran continuously for 16,800 minutes, or an equivalent of 50,400 molds, are still in service. Full vibrator equipment, in sets assembled ready to attach to molding machines, is also furnished. This includes the vibrator, knee valve, pet cock for throttling the vibrator down to the



VIBRATOR MANUFACTURED BY THE BERYK CO.

desired strength, air hose, clamps, nipples and all necessary attachments. The advantages claimed for the new model vibrator are the sure-starting qualities, durable design and economy of air.

Electric Cranes for Foundry Use

The monthly meeting of the Philadelphia Foundrymen's Association, held at the Manufacturers' club, Philadelphia, Feb. 2, was featured by the presentation of a paper on "The Electric Crane in the Iron and Steel Foundry", by P. E. Austin, assistant manager of the crane department of the Niles-Bement-Pond Co., Philadelphia. Mr. Austin said, that not many years ago the jib crane was the type generally used for foundry work, so that it is not surprising that it still has its advocates. This type of crane is handy, and for some purposes is desirable, but the most serious objection to it is its lack of flexibility and its limited range, thus confining all operations within its fixed radius. Investigation has proven that if only one crane can be installed, it should be of the overhead type, preferably electrically-operated. This type of crane, Mr. Austin added, is the most efficient, adaptable and flexible unit which may be installed

in a foundry, and it has come to be recognized as one of the most important factors in promoting economy in manufacture. The large output now attained in iron and steel foundries, steel mills and machine shops would be impossible without the use of such cranes to handle material rapidly.

The factor of safety is one of the prime considerations in designing cranes. The crane must be able to handle a load up to its rated capacity, with a big margin of reserve to compensate for wear, and to withstand abuse, thus eliminating the possibility of accidents which might endanger the operator or the men working beneath the crane. The crane should be quick-acting, responding as soon as the current is turned on, so that all of its movements may be available simultaneously. The crane should be efficient and should be capable of operating continuously for long periods with a minimum amount of delay for attention or repairs. The control of the various movements of the crane should be so adjusted that operations, such as setting a core, lifting a cope or closing a mold may be performed with exactitude and ease, leaving the crane free in the shortest possible space of time to be engaged on other work. All parts of the crane should be accessible for examination and repair; each distinctive part must be readily removable and hand-rails, toe-guards and other safety devices must be provided.

Special Types of Cranes

Special types of cranes also are used to advantage in foundries. Among these is the mono-rail hoist, designed to run upon the lower flange of an I-beam, which is used extensively in performing various duties, such as charging the cupola, handling raw materials, transporting pipe in pipe foundries, and as an adjunct to overhead cranes. Another special type of crane, for handling coal, coke or sand advantageously, is the grab bucket trolley. The revolving jib crane also may be installed as an economical adjunct to the overhead traveling crane. For handling material in the yard, the gantry crane is highly efficient. A special type of crane which is employed extensively in modern foundries is the wall crane.

Mr. Austin's talk was accompanied by numerous lantern slides which illustrated different types of Niles cranes. There also was a large number of views showing typical and special crane installations in iron and steel foundries; some of these reflected the flexibility of service which may be obtained by using special types of cranes in conjunction with overhead traveling cranes. These views were taken at the plants of the Deemer Steel Casting Co. and the Baldt Steel Co., New Castle, Del.; the American Rolling Mill Co., Middletown, O.; the Norfolk & Western railroad, Roanoke, Va.; the Niles Tool Works Co., Hamilton, O. and other concerns.

WHAT THE FOUNDRIES ARE DOING

Activities of the Iron, Steel and Brass Shops

C. H. Schutt will establish a foundry at Livingston, Mont.

C. C. Barnett and M. P. Haag are establishing a foundry at Oxnard, Cal.

The Atlas Steel Casting Co., Boston, has been incorporated with $5,000 capital.

S. J. Sullivan, of Hot Springs, Ark., will equip a foundry and machine shop at Argenta, Ark.

The Grand Rapids Brass Co., Grand Rapids, Mich., will estatblish a brass foundry at Belding, Mich.

The Kalamazoo Match Plate & Foundry Co., Kalamazoo, Mich., has been organized with $3,500 capital.

The A-B Enameling & Foundry Co., Battle Creek, Mich., has changed its name to the Ajax Enameling & Foundry Co.

The Builders' Foundry Co., Boston, has been incorporated with $5,000 capital stock by R. B. Skinner, Herman S. Tay and L. A. Brimmer.

The West Penn Foundries Co., Pittsburgh, has been incorporated with a capital of $5,000 by G. K. Warn, S. L. Ruslander and Norman B. Lovejoy.

The National Bronze & Aluminum Castings Co., Detroit, has been incorporated with a capital of $10,000 by P. J. and V. R. Donnelly and Robert L. Pratt.

The H. J. Walker Machine Shop & Foundry Co., Cleveland, has been incorporated with $25,000 capital. A plant has been erected on East 131st street.

The Manitoba Steel Foundries, Ltd., Winnipeg, Man., Can., has been incorporated with $100,000 capital to engage in the manufacture of steel castings.

The Columbus Foundry Co., Columbus, O., has been incorporated with a capital stock of $1,500 by William Staples, William Summers and Charles Linsmith.

The H. L. Dixon Co., Pittsburgh, has leased the plant of the Stahler Machine Co., Mount Union, Pa., which will be used for the manufacture of castings.

Pittsburgh capital has leased and put into operation the Bolivar Foundry & Machine Co.'s plant, Bolivar, Pa., owned by J. S. Miller and which has been idle for many months.

The Lister Sash Weight Co., St. Louis, has been incorporated with a capital stock of $25,000 by A. E. Poss, F. B. Hooper, L. E. Mc-Commons, Laura L. Hooper and D. J. McCarthy.

The Federal Brass Co., 1767 East Eighteenth street, Cleveland, has been organized to manufacture plumbers' brass goods, by E. H. Blywise, formerly affiliated with the Monarch Brass Co., Cleveland.

The new foundry of the Premier Aluminum Foundry Co., Ivanhoe road and Nickel Plate railroad, East Cleveland, O., has been placed in operation. It is equipped to manufacture aluminum, brass, bronze and copper castings.

The Connecticut Alloyed Metals Co., Millbrook, N. Y., has been organized with a capital stock of $15,000 to engage in the manufacture of metals, alloys, and metallic compounds, by Joseph Beihilf, E. Dennes and others.

The Penn Foundry & Mfg. Co., Reading Pa., has been incorporated with a capital stock of $15,000 by Edgar P. Fidler, James L. Mark and George W. Bland. The company has taken over the former Wyomissing foundry at Wyomissing, Pa.

The Pembroke Iron Works, Pembroke, Ont., Can., has been incorporated with $100,000 capital stock to engage in the operation of a foundry and machine shop. The incorporators are James F. Munro, Peter White and Thomas Pink.

The Waterbury Brass & Bronze Co., Waterbury, Conn., has been incorporated with $10,000 capital to engage in the manufacture of brass and aluminum castings and ingots. Henry L. Silver, Harry W. Even and Edward B. Riley are the incorporators.

The Clark Co., West Newton, Pa., has been incorporated with a capital of $25,000 to engage in the manufacture of wrought and cast pipe, fittings, railings, tools, etc. The incorporators are J. G. McCune, W. E. Clark and T. J. Parker.

The Marshall Foundry Co., Pittsburgh, manufacturer of ingot molds and heavy castings, has acquired the ingot mold plant of the Bollinger-Andrews Co., Pittsburgh, located at Josephine, Pa. The latter company will continue to operate its plant for fabricating steel at Verona, Pa.

The National Art Bronce Works has established a plant at 2337 Pope avenue, St. Louis. This concern, which was formerly known as the Alloyed Metal & Mfg. Co., specializes in ornamental and architectural bronze castings, including statuary of all sizes, bas-relief panels, tablets, etc.

The Newark Stamping Co. has merged with the Moser Pattern & Foundry Co. and the Huffman Plating Works, all of Newark, O. The new company will be known as the Newark Stamping & Foundry Co. and will manufacture castings, automobile accessories and a hose clamp and will do pattern work, plating and metal spinning.

The Berks Foundry & Mfg. Co., Berks P. O., Berks Co., Pa., has been incorporated

to engage in the manufacture of a general line of gray iron castings. The new company has purchased the plant of the A. & H. Foundry Co., Hamburg, Pa. The officers are: President, W. T. Adams, of the Adams Mfg. Co., Reading; secretary and treasurer, G. Frank Rickert, Keystone Badge Co., Reading; manager, M. A. Dunlap, Pottsville. Directors include the foregoing, C. K. Derr and A. L. Luria, Reading.

New Construction

The Williams Mfg. Co., Montreal, Que., Can., will build a foundry.

The Roberts Brass Mfg. Co., Detroit, is erecting an addition to its foundry.

The All-Steel Motor Co., St. Louis, will build a foundry at Macon, Mo.

Love Bros., who operate the Aurora Foundry Co., Aurora, Ill., will build an addition to their plant.

The King Bronze & Aluminum Co., Cleveland, will build an addition to its plant at 1730 East Thirty-seventh street.

Stanley F. Kadaw, 988 Kinnickinnic avenue, Milwaukee, is preparing plans for a foundry, 65 x 80 feet, to cost $10,000.

The Western Iron & Foundry Co., Wichita, Kas., will erect a reinforced concrete foundry at a cost of $4,000.

Plans are being prepared for a foundry, 90 x 300 feet, to be erected for the Berlin Machine Works, Beloit, Wis.

The South Bend Foundry Co., South Bend, Ind., is building a 40 x 100-foot addition to its core room.

The Sharon Foundry Co., Sharon, Pa., is increasing the size of its steel foundry at Wheatland, Pa., to 30 x 100 feet.

The Liberty Foundry Co., 7600 Reilly avenue, St. Louis, will build an addition to its plant, 83 x 153 feet.

The Wisconsin Aluminum Foundry Co., Manitowoc, Wis., will build a 60 x 140-foot addition to its foundry.

The Duriron Casting Co., Dayton, O., will build an addition to its foundry at a cost of $5,000.

The Hoover Suction Sweeper Co., New Berlin, O., manufacturer of suction sweepers, is equipping an aluminum foundry, which will be placed in operation about March 1.

The Modern Pattern Works, Toledo, contemplates the erection of a pattern shop, 60 x 80 feet. Plans for the erection of the plant are now being prepared.

The G. T. Eames Co., Kalamazoo, Mich., recently incorporated with $10,000 capital, contemplates the erection of a foundry, 80 x 150 feet.

The Covall Mfg. Co., Benton Harbor, Mich., is building two additions to its plant, 80 x 100 feet and 32 x 75 feet. The company manufactures gray iron castings.

Swayne, Robinson & Co., Richmond, Ind., will erect a foundry, 35 x 127 feet, of concrete, brick and steel construction, at a cost of $10,000.

The Stearns-Rogers Foundry Co., Pueblo, Colo., is erecting a 90 x 220-foot addition to its machine shop at a cost of approximately $75,000.

Gallagher, Hutchinson & Campbell Bros., Muskegon Heights, Mich., have leased a plant at Marshall, Mich., which will be remodeled for the production of brass, iron and aluminum castings.

A contract has been awarded for the erection of a story foundry and a three-story warehouse for the Great Western Smelting & Refining Co., 3108 North Broadway, St. Louis. The estimated cost is $50,000.

James M. Cumming has purchased the plant of the Phoebus foundry, Phoebus, Va., from George C. Thomas, Baltimore. The foundry will be opened after extensive alterations have been made.

The Piston Ring Co., Muskegon, Mich., is doubling the capacity of its plant by the erection of a new building. This company operates a gray iron foundry for the manufacture of piston rings.

The Kokomo Brass Co., Kokomo, Ind., contemplates the erection of a large aluminum foundry. This company already operates a casting plant for the manufacture of bronze and brass castings.

The South Bend Foundry Co., South Bend, Ind., manufacturer of gray iron castings, is building a 40 x 100-foot addition to its foundry which will materially increase the capacity of the plant. C. C. Lee, formerly with the E. M. F. and Studebaker corporations, is superintendent of the shop.

The Boaz Emergency Mfg. Co., Chattanooga, Tenn., has been incorporated to engage in the manufacture of heaters, stoves, patterns and castings of different kinds. A building 40 x 60 feet and two buildings 80 x 200 feet will be erected. Considerable equipment will be installed, including cupolas, traveling cranes, foundry equipment and woodworking machinery. William B. Boaz, 2427 Central avenue, Hamilton, O., is president and general manager.

The National Steel Casting Co., recently organized with $100,000 capital, has completed plans for the erection of a plant at New Cumberland, W. Va. The main foundry and machine shop building will be of steel construction, 165 x 300 feet, and will house a 15-ton open-hearth furnace and a small electric furnace, together with auxiliary equipment. The plant will have a monthly capacity of approximately 400 tons. A brick pattern shop, 30 x 100 feet, will be erected. E. E. Kramer, identified with Heyl & Patterson, Pittsburgh, is president of the company and Joseph Halbe, formerly connected with the Reliance Steel Casting Co., Pittsburgh, will be superintendent. Messrs. Kramer and Halbe, together with Paul Dadowski, John Halbe and E. Pertel form the directorate. The company will maintain an office at Pittsburgh.

NEW TRADE PUBLICATIONS

PNEUMATIC COMPRESSORS. — The Chicago Pneumatic Tool Co., Chicago, is sending to the trade a 16-page booklet devoted to pneumatic compressors, fuel oil and gas engines. The equipment is briefly described and the pages of this pamphlet illustrate the extensive and varied line of this equipment manufactured by this company.

PNEUMATIC DRILLS.—A 40-page bulletin has been issued by the Ingersoll-Rand Co., New York City, describing its extensive line of pneumatic drills adapted for drilling, reaming, tapping, flue-rolling, wood-boring, seating studs, tightening bolts, running down screw spikes, valve setting, etc. The pamphlet is well illustrated, numerous views being included of actual operations on various classes of work.

BUCKETS.—The Hayward Co., New York, has issued an attractive pamphlet showing its different types of buckets, adapted to a wide variety of service. The Hayward Co. manufactures orange peel, clam shell, drag scraper and electric motor clam shell buckets; skid excavators, dredging machinery, traveling derricks, counterweight drums and coal handling machinery. The pamphlet is profusely illustrated.

ELECTRIC VIBRATORS. — The Magnetic Mfg. Co., Milwaukee, has issued a 16-page bulletin devoted to electric vibrators for use in foundries. Illustrations are presented showing vibrators for rapping patterns and molds. Various types of this device are made for use on benches, squeezers, heavy molding machines and pattern plates. The arrangement of the generators and attachments is explained and diagrams are given showing the method of wiring to accommodate several vibrators.

AIR HOISTS. — The Whiting Foundry Equipment Co., Harvey, Ill., describes its extensive line of air hoists in a 20-page catalog recently issued. These hoists are particularly adapted for handling molds and for other operations in casting plants. Hoists of both the vertical and horizontal types are built. Several interesting views are included showing the handling of molds with these hoists in casting plants.

SAFETY GOGGLES.—A 20-page pamphlet entitled "Let Us Save Your Workmen's Eyes" has been issued by the Julius King Optical Co., New York City. The various types of goggles manufactured by this company are illustrated, as well as an electric drop test apparatus which is employed for testing the strength of lenses. Numerous views are shown of goggles, the lenses of which have been broken in service without injury to the eyes of the wearer.

CUPOLAS.—A 32-page catalog issued by the Whiting Foundry Equipment Co., Harvey, Ill., is devoted to the line of cupolas manufactured by this company, as well as the accessories required in gray iron melting operations. This edition of this cupola catalog contains many new illustrations showing the latest improvements in the design of the Whiting cupola. The tuyere system is shown in detail and a special test cupola is described. The accessories include spark arresters, roof hood, screen charging doors, blast gages, blast pipe, blast gates, bottom door hoists, cupola charging machines, cars, etc. Several illustrations also are included showing large installations of these melting mediums.

WELDING AND CUTTING APPARATUS. —The Bishop-Babcock-Becker Co., Cleveland, has issued a new edition of its catalog describing its oxy-acetylene welding and cutting apparatus. The company's diaphragm safety device is illustrated and described in detail. This device is positive in action and automatically relieves any excess pressure in the valve which may be caused by cracking, creeping or destruction of the seat; by the deposition of iron rust from the oxygen cylinder; or by carelessness of the operator. Phosphor-bronze diaphragms are used for the oxygen regulators and silver diaphragms for the acetylene. In addition, the catalog describes the company's complete line of oxygen and acetylene welding and cutting regulators, pressure gages, welding and cutting torches, valves and decarbonizing devices.